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NEW YORK, JULY, 1887.

A SMALL vessel which shall be capable of high speed and which shall, at the same time, be seaworthy and able to carry a heavy load for her size, is not an easy problem for a shipbuilder to solve. These were the conditions required in the fleet of torpedo boats which have recently been built for the English Government at private shipyards. At first these boats seemed to be successful, and some of them developed extraordinary speed in smooth water. A trial at sea, however, has resulted less favorably, and in a run of 50 miles, made as nearly as possible under conditions which would appear in active service, one-third—8 out of 24—of the boats broke down, several of them completely and disastrously; two of the failures causing loss of life.

This is hardly a creditable record for the builders, and perhaps for those in charge of the boats. Apart from all structural deficiencies, however, it looks very much as if the torpedo boat as heretofore designed was rather a bad vessel to handle and likely to be almost as dangerous to her owners as to the enemy. At best it is only available for use in smooth water and fair weather.

It is true that torpedoes are depended on for service chiefly in shore and harbor defence, and are not to take much part in sea warfare; but it can hardly be expected that a fleet should be provided for every port on a long coast line, such as that of England or the United States. Torpedo boats cannot well be adapted for long voyages, but should at least be able to transport themselves from point to point along the coast without blowing up or foundering by the way.

IF, as we are often told, the highest civilization will make war a relic of the past by referring all international disputes to a peaceful settlement, we must be still a good way below that highest plane. Just at present it seems as if much of the best engineering talent, both in America and Europe, were engaged in perfecting the means of national attack and defense. The Mechanical Engineers' Society at its Washington meeting devoted a considerable part of its working time to hearing and discussing papers on steel for guns and armor-plate and on national defenses, thus following the example of the Civil Engineers, who occupied several of their monthly meetings during the past season on the same subject.

In one sense such discussions and the wide interest taken in them are not an encouraging symptom, and the time and thought expended might be better employed. On the other hand it may be said that we cannot wait for an ideal state, but must take things as we find them, and from this point of view there is much to be said in favor of the popular feeling that, if other nations are in a position to attack, we must be ready to defend ourselves. This view involves the necessity of providing ships and guns of the most approved patterns, and if we must have these, there should be full discussion of the subject and by the most competent persons. Hence, it is well that our civil and mechanical engineers should bring their experience to the assistance of their naval and military brethren, who will, it is presumed, be ready to accept the help thus offered.

A PAPER presented to the British Institute of Mechanical Engineers on some locomotives built for the Canadian Pacific road drew out a long discussion on the relative merits of American and English locomotives. Some of this discussion was intelligent, but much of it was rather in the line of mere assertion without proof, and disclosed a good deal of the insular prejudice which the English engineer is apt to have against all things foreign. There are plenty of liberal-minded English mechanical engineers who are quite ready to recognize good practice anywhere; but there are also, unfortunately, many who will not admit that anything really good can come from outside their own conntry. This kind of men can be found on this side of the Atlantic also, but they are fewer in number and less prominent than among our British brethren.

Some of the feeling expressed in this particular discussion may have been due to a not altogether unnatural irritation at the fact that Canada, although an English colony, has long ceased to furnish a market for English locomotive builders.

THE Sind-Peshin Railroad, which is a military line on the Afghan frontier of India, runs through a country which, from the descriptions given of it, seems to resemble very much the mountain sections of Colorado and Utah. Its construction involved the solution of engineering problems very similar to those met with in the building of the Denver & Rio Grande and other roads in that territory. The Sind-Peshin line was built by English military engineers, who had entire charge of the work, but one of them, in describing the road, notes that American methods of location and construction proved the most successful and were largely adopted. From the source from which it comes this may be taken as a high compliment to American engineers.

In building this road speed was more an object than cost. It was built entirely for military and political reasons, and there was no question as to whether it would be commercially profitable or not. American methods were adopted, not so much because the road could by them be cheaply built, as because they were better and easier.

It is to be noted that on this line, though it ran through so difficult a mountain country, there was no talk of narrow gauge. The gauge adopted was 5 ft. 6 in., simply because that was the gauge of the connecting line.

A SINGULAR objection to iron sleepers is noted by an English engineer who has had much experience in the building of military lines on the northern frontier of India. The wandering Afghan or Belooch who infests those parts, he says, is a mischievous creature, who is very fond of testing the strength of an iron tie with the biggest boulder he can bring to bear upon it, or with a sledge-hammer, if he is able to steal one. On the particular line where these inquiring gentlemen most abound, the ties sent out from England were of cast-iron, and the boulder generally got the best of it, with disastrous results to the track.

THE bill to provide for the safety of travelers, which has been signed by Governor Hill and has become a law, prohibits the use of stoves either inside, or suspended from, a passenger car in the State of New York after May 1 of next year. Stoves now in use may be retained in the cars, but their use is to be permitted only when the cars are standing still, or temporarily in the case of accident or emergency.

Like most laws of this description, the present one seems too sweeping in some of its provisions. That it is possible to make a car-heater or stove which will be safe in almost any contingency, there can be no doubt, and it is possible to frame a law which would permit the use of such a heater and exclude those in which there are elements of danger. If, however, it is admitted that a system of continuous heating by steam or hot-air from the locomotive or a special car is the only plan which is really safe, the new law appears to be defective in allowing stoves to remain in the cars at all. Certainly the use of stoves in standing cars and in case of emergency seems to leave a pretty fair chance for evasion of the law, of which some railroad managers will not be slow to take advantage.

The time allowed before the law takes effect gives railroad managers another winter for trial of the different devices for continuous heating offered to them, and no complaint can be made in this respect. Practically, they have nearly a year and-a-half to prepare themselves, as the law takes effect May 1, 1888, and heating apparatus will not be required for five or six months after that.

THE provision of the law prohibiting the use of car-stoves in New York State, which exempts railroads less than 50 miles in length from the operation of the law, appears to be a serious defect. It seems to have been inserted on the theory that short roads carry but few passengers and are not able to bear the expense of new heating apparatus. But, apart from the consideration which might be urged that passengers on short roads are, at least, as much entitled to protection as those on the longer lines, there are, at least, three or four roads which might be named, and which come under this clause of the law, which carry a large number of suburban passengers to and from New York every day, and on which thousands of lives are yearly exposed to danger. Now, on all of these roads are a number of old cars which are provided with the simplest and most dangerous pattern of cast-iron stoves—heaters which are tolerably certain, in case of any serious accident, to upset and break to pieces, scattering their fire in every direction. Probably the number of passengers carried yearly on these roads exceeds that carried on all the through express trains run by the trunk lines of the State, and it certainly seems as if they were entitled to equal protection.

THE Cleveland *Iron Trade Review* announces that some experiments, which have been conducted for some time by the Cleveland Rolling Mill Company, under the direction of Mr. Eugene H. Cowles, the inventor of the process which led to the production of aluminium bronze, have been very successful in these experiments. Large steel castings, made with steel charged with 0.1 per cent. of aluminium, showed an extraordinary freedom from blow-holes and other defects, which are common with ordinary steel castings, and also showed a remarkable increase in tensile strength. Moreover, it was found that the addition of this small percentage of aluminium imparted to the steel the property of making a clean and perfect weld with wrought-iron. The alloy also greatly reduced the chilling of the metal, permitting it to enter the mould readily and to fill it completely, as was shown especially in the casting of a number of gear-wheels.

Should further experience justify the deductions drawn from these experiments, the discovery is an exceedingly important one and will largely increase the uses to which cast-steel may be applied.

THE plans for the Metropolitan or City Railroad in Paris, which have now been under consideration for over two years, have finally been adopted and work will be commenced on the lines as soon as these plans receive the approval of the Legislative Chamber. The general plan includes a system of 36 kilometers in all, a circular line connecting the stations of the different trunk lines entering the city and four transverse lines, crossing nearly at right angles, each of these lines connecting with the circular line at two points in its course. To these, which will constitute the principal system, are to be added two lines, 7 kilometers in all, extending beyond the circular line into the suburbs. Of the entire length of 43 kilometers embraced in the system, about 9¼ kilometers will be elevated railroad, 28 underground, and the remaining 6¼ in a covered subway or cut. All the lines will have two tracks of the standard gauge, and connections will be provided by which trains from the railroads entering the city can be taken at once, without transfer, to any point on the city line. It is not intended that trains shall be so run in ordinary traffic, but this is really a military precaution, taken in order that troops brought from any point may be landed anywhere in the city of Paris where it is desirable to have them.

The elevated line will be a masonry viaduct, which will not follow the line of any streets, but will, as we should say in New York, cut "through the blocks," making its own road and having a lateral street on either side of it. As in the Berlin City Railroad, the arches of the viaduct will be, wherever possible, utilized as store-houses and for similar purposes. Two bridges over the Seine will be required and will be of iron.

The other crossings of the river will be tunnels or sub-

ways, and it is proposed to construct these tunnels of iron tubes, but, the official report says, a special study will be made of these subways and some alterations in the plan, though not in the location of the road, may be required.

There will be altogether on the whole 43 kilometers of line, 68 stations, of which 14 will be on the elevated line, 12 on the covered cutting and 42 on the tunnel line. These stations will be very simple in construction, but will be planned to give abundant space for the large traffic expected. Three of these stations will be for through passengers, where baggage will be received for all the railroads running out of Paris.

The rails to be used will be of the "bull-head" type, and it is probable that iron or steel ties will be used. As the road, when not underground, will be upon a solid viaduct, ballast will be used in the ordinary way.

Paris has never had any system of city steam railroad, having been entirely dependent for city traffic upon the omnibuses, tram-cars, and carriages or hacks. There is a belt railroad running around the city, but it is used entirely for transfer of freight between the railroads and it has little or no passenger business. This belt line, moreover, was not located with a view to serving the city or accomodating passengers, but chiefly to connect the outer line of fortifications built to protect the city against a hostile army. The new City Railroad will be entirely a government affair, and its cost, we believe, is to be paid partly by the General Government and partly by the municipality of Paris.

TECHNICAL education in the lower sense—that of instruction in the actual manipulation of materials and workshop practice—is now strongly advocated and is apparently growing everywhere in popular favor. To a certain extent this is well, but there is some danger that it may be pushed to excess. Practical instruction is necessary, but not to the exclusion of the theoretical, and that is very apt to be the outcome if the present tendency is followed too far. It is not long since that the movement was in the opposite direction, and the theoretical technical education was pursued to the exclusion of the practical, so that the new movement is really part of a natural reaction. It is also a part of the general tendency of our more complicated modern life to divide up and specialize education as much as possible.

The modern workshop school is also an effort to replace the old system of apprenticeship which is now passing away. That it can fully do so is not possible, for no combination of shop and school can teach a boy what he can learn in three or four years of actual shop work. This much can safely be said, however, that a little practice with tools mixed with his book lessons will do a boy no harm and may do him much good, especially if he is not taught to rely on it too much or to consider it a complete outfit for his future trade.

IT is stated that the Abt rack-rail system is to be tried on the English military railroad through Bolan Pass, on the Afghan frontier of India. Materials for 10 miles of road have been sent out, with two locomotives, and the road will be laid this year.

The success of the Abt system on the Harz Railroad has attracted much attention, and this Indian case is only one of several proposed applications of the system.

PERSONS interested in the eccentricities of maintenance of way can see a fine collection of low joints on the Northern Railroad of New Jersey between Sparkill and Nyack. For some three miles each rail forms an arch, the curvature being plainly visible to anyone walking along the track. The rails are of steel, somewhat worn; the joints are the plain fish-plate with four bolts, and are between ties. There are heavy grades over the whole of this section, and the effect on the locomotives of the additional work of climbing over all these little arches may be imagined.

A VERY discouraging view of the condition of the Panama Canal was given to the American Society of Civil Engineers by M. Boulangé, a French engineer recently employed on the canal. His statements corroborate the report recently made by Lieutenant Rodgers, and it was evident, to those who heard him at the Society's meeting, that he spoke with acquaintance of his subject and with full conviction of the correctness of his views. With less than one-quarter of the actual excavation done the company has already spent $180,000,000, part of which was raised at a ruinous discount, and it has now funds on hand for only a few months longer, with very little prospect of raising more. It is true that the enormous sum already spent includes the period of installation, when heavy payments for engineering and plant might be expected; but, on the other hand, some of the most difficult and expensive work has not even been touched, or has barely been begun.

Thus the great Culebra cut has only just been commenced, and the little work done there has developed difficulties altogether unexpected and apparently very difficult to overcome. The damming or diversion of the Chagres River, a work essential to the success of the canal, is so far from execution that no plan for it has yet been settled on, and the engineers agree only in considering it an extremely difficult problem to solve.

The future of the canal is just now exceedingly uncertain, but it does not appear probable that the company will be able to go on much longer with the work. A suspension is to be looked for, though a total abandonment will be postponed as long as possible.

THIS and other accounts of the Panama Canal reveal an almost incredible looseness in the technical administration. That so important a work should be undertaken without sufficient maps and without a really definite final location is sufficiently startling; but when we are told, on apparently good authority, the chiefs of section are required to work without maps, profiles or anything else, in fact, to guide them, it is difficult for engineers to believe that such an administration is possible.

THE American Water-Works Association, which holds its seventh yearly convention at Minneapolis on July 13, is a society whose proceedings should excite much more interest than they usually do. The Association includes a number of engineers of standing, and the general subject of which they treat is one which comes close, not only to the engineering profession, but a large majority of the people. Water supply affects all of us in some degree, and a very large part of our population is now resident in cities and towns where water-works of some kind are

needed. There are many questions, some of them of a difficult nature, to be considered in this convention, and there is abundant room for the exercise of skill and talent by engineers in their solution.

RAILROAD bridges are to be one of the leading subjects for discussion at the Civil Engineers' Convention, the points to be especially treated being the proper inspection of bridges, the strength of floors and the use of safety guards.

In this connection also it is suggested that the discussion include the question of reference of these and similar subjects to committees for consideration and report, and also the question whether it may not be both possible and desirable for the Society to adopt some standards as the Master Car-Builders' Association has done. On this last point there is likely to be much difference of opinion.

TECHNICAL EDUCATION ON THE BALTIMORE & OHIO RAILROAD.

A REPORT, which marks a new departure by the old and conservative Baltimore & Ohio Railroad Company, has recently been issued by Dr. W. T. Barnard, the Assistant to its President. The report is intended to show the economic value of technical education in the development of the industrial arts, and especially in railroad operation.

A person familiar with the ways of the Baltimore & Ohio Company and its officials 25 or 30 years ago, in reading this report, feels somewhat as Rip Van Winkle probably did when he woke up after his long sleep. Whatever may have been the merits of the late Mr. Garrett's management, he certainly did little to encourage the application of science to practical railroad management. The publishing of this report and the creation of a technical school by this company indicates that the present officers have a higher estimation of the value of education than their predecessors had, although the author of the report says that "no one but the writer stands committed to the statements or views therein contained."

A great difficulty in the way of carrying out a scheme like that outlined in the report referred to is that the great mass of workmen do not value or care for education or technical knowledge. That this is the case on the Baltimore & Ohio Railroad is shown by the report, which says:

"When tastes for reading and study are not cultivated in youth, they are seldom acquired in later life by those engaged in manual occupations. In proof of this, I cite the fact that though there is a commodious library and reading room at Mt. Clare, fairly equipped with works of science and industrial mechanics, and where all the important scientific journals are displayed for the especial benefit of our employés, the record shows that, during the past year, out of an average of 3,000 workmen at Mt. Clare, fewer then 50 visited the library at all, and fewer than 15 utilized these journals; thus conclusively showing that they have not sufficient education to appreciate these valuable means of further improvement. Out of 16,120 books circulated during the year, but 1,816 were of a strictly educational character, and they were almost exclusively drawn out by young men and boys attending our class-instruction. A very careful canvass last year, demonstrated the fact that, among this great mass of labor, only one man subscribed to a technical journal, and that man was an ordinary mechanic. A logical deduction from this record is that *our people have little or no knowledge of current improvements, or of the results of scientific investigations of mechanical subjects, and, as a rule, they only know methods crude and generally obsolete elsewhere, and observation confirms this.*"

Again, in a report dated January 30, 1887, Mr. Coler, the principal of the school, says that he and his assistant examined nearly 500 apprentices in the shops of the company and "*that not one of them* was sufficiently advanced to pursue technical studies with profit to the company and to himself. * * * Combined with this lack of elementary knowledge was a corresponding lack of inclination on the part of these apprentices to make of themselves anything more than ordinary routine and rule-of-thumb mechanics." The author of the report concludes "that to try to educate boys who have not formed habits of study before entering upon apprenticeship is a useless waste of time, patience and money."

Of the good effects on the industries of a country or a community of the dissemination of technical education, the report before us contains ample testimony, but that it is essential or important to the great majority of the operatives of a railroad may be doubted. In what way would a knowledge of algebra improve a man's efficiency, who is employed in turning car-axles from one year's end to another? It is doubtful whether a knowledge of the chemistry of combustion will make a fireman more efficient than he would be without. Perhaps thermo-dynamics might help a locomotive runner to save fuel, but it is very doubtful. A blacksmith's helper or a boiler-maker would not be any more efficient, in their respective occupations, if they understood the principles of statics and dynamics than if they do not. In the very nature of things, many men must be constantly employed on a railroad to turn axles, to fire and run locomotives, make boilers and forgings, and similar occupations for which manual skill, industry, endurance, and faithfulness in the performance of duty are the essential qualifications.

It is in the management of the different departments of a railroad that scientific knowledge has its chief value. The old dispute about the relative value of practical and theoretical knowledge will not be taken up here, as anyone with experience knows the two should be combined. But if technical knowledge is to have any value in the management of railroads, those who have that knowledge must have adequate authority. Now, on the Baltimore & Ohio Railroad we have the curious anomaly that the authority of the heads of the engineering departments is made subordinate to that of the Purchasing Agent. It may fairly be presumed that the Superintendent of Machinery and Chief Engineer of a great road, which has organized a school, on a liberal scale, for the education of its employés, would be men of adequate practical and scientific training to qualify them for the responsibilities of the positions they hold.

Such training will be of very little use unless those who have it also have the requisite authority to manage the road. Few men with the knowledge which the head of any of the principal departments of a road like the Baltimore & Ohio Railroad should have, would be willing to have his authority over the department for which he is held responsible made subordinate to that of a person whose chief duty and only qualification is that of driving a sharp bargain with those who sell what the company must buy. Therefore, the educational scheme and the distribution of authority on the Baltimore & Ohio Railroad are antagonistic to each other. This company will

be obliged either to stop educating its employés or to suppress its Purchasing Agent, because men of any considerable degree of scientific knowledge and practical experience would have careers open to them in which they would not be made subordinate to a person whose chief distinction is that he excels a Bowery clothing dealer in driving sharp bargains.

Of late years it has been almost impossible for any one, no matter how extensive his knowledge or experience concerning the mechanism, engineering or operation of railroads might be, to communicate with the Baltimore & Ohio officials excepting through the Purchasing Department.

The head of that department is judge, jury and expert in matters of which he is profoundly ignorant, in which he will hear no argument, and from his decisions there is no appeal. He treats many who have business with the company with so much insolence that those who have sufficient independence refuse to have any dealings with him. Some of the largest manufacturing establishments refuse to bid on work, the orders for which must come through his hands, and his name is execrated from one end of the land to the other by those who have had, to come in contact with him. If the Baltimore & Ohio Railroad Company determines to continue its educational scheme, one of the first things to do should be to establish a department for instruction in the amenities of business intercourse and compel its Purchasing Agent to spend half a century or so in that kind of study.

There is great room for doubting whether it is any part of the duty or function of a railroad company to undertake the education of its employés, excepting in matters pertaining directly to the main purpose for which a railroad company is created, which is to carry freight and passengers. It obviously should teach its locomotive runners how to manage their engines and operate the brakes, because that kind of information is not taught in the schools. It is important, too, that its workmen should understand drawings, and unfortunately drawing is not taught in the schools as generally as it should be, and therefore workmen must learn it elsewhere. As mechanical drawing can be taught best in connection with a workshop, it is always well to give men a chance to learn how to draw the objects with which they are familiar. Instruction in other branches which have a special application to their occupations may be desirable, but nearly every State, city and town now gives ample facilities for getting even more than what is called a common-school education. A railroad company may with advantage supplement the common schools, and teach specialties relating to the work of its employés, but it is very doubtful whether it can or should assume to do what the schools are created for. If it aims to give a thorough course of technological instruction it will probably fail, as railroad officers rarely have the qualifications required for conducting a school of science.

If instead of attempting to educate its own men the Baltimore & Ohio Company would make its service attractive to those who have been educated elsewhere, it would be likely to attain what it is aiming at sooner than it will through the technical school which it has organized with commendable liberality. The first thing to do to make its service attractive, is to cut the wings of its Purchasing Agent, who now soars so arrogantly over all who are unfortunate enough to be obliged to have any dealings with him. Instead of attempting to educate men, that company would do much better to find those who have received their theoretical education elsewhere and give them a chance to get their practical experience in the service of the Company. The Pennsylvania Railroad adopted this plan years ago, and the results are known the world over.

THE POUGHKEEPSIE BRIDGE.

WORK on the great bridge over the Hudson River at Poughkeepsie is in such a condition that its completion is now, apparently, reasonably sure, after years of effort on the part of its projectors and of continually recurring disappointment. At first the apparent success of the Poughkeepsie Bridge had the effect of stimulating the rival projects for bridges over the river, and the advocates of the proposed bridge at Storm King and the suspension bridge at Anthony's Nose, near Peekskill, were active in urging the advantages of their plans. Lately, however, nothing has been heard of them, and the bridge at Poughkeepsie seems likely to be, for some time at least, the only bridge crossing in the 150 miles between Albany and New York.

The Hudson is the last of the great rivers of the United States to be bridged. The Mississippi, the Missouri and the Ohio have been crossed at many points in the West, and the Delaware and Susquehanna in the East are spanned, but the Hudson has remained clear of bridge crossings through nearly all its navigable length. There have been projects enough for many years back, and they have had plenty of advocates, but the Poughkeepsie Bridge is the only one that has ever reached the stage of actual construction. This is not so much the result of physical obstacles, for there are several points at which bridges are entirely practicable without serious obstruction to navigation, in the light of late experience with long spans, and hardly anywhere along the river would such difficulties be encountered in building the substructure as have been overcome at several of the bridges over the Missouri and the Mississippi. The Hudson is broad and deep, and is, in fact, more a tidal estuary than a river; but the high, rocky banks which mark much of its course, and the rock bottom which can be found at most points at a moderate depth present conditions favorable to the engineer. It carries an immense traffic, and a very large part of it is in the form of long tows of barges and canal boats which require room for their handling; but these can be provided for by spans which do not exceed in length some which were successfully erected years ago. The river boatmen have actively opposed the building of the bridge now under construction, but it does not appear that any greater difficulties will be found in passing the largest tows between its piers than are now experienced in handling them in the narrow channels between Albany and Catskill. There are also the advantages that the river is comparatively free from such strong and dangerous currents as affect the navigation of the Mississippi or the Missouri, and that its channel is stable and unchanging.

The real causes for the delay in bridging the Hudson have been the absence of such a pressing necessity for a crossing as has existed elsewhere, and a general doubt as to whether a costly bridge would pay. The larger part of the rail traffic from the West to New England has for many years taken the route through Albany, and canal

traffic which was bound for that section of course requires no bridge, as the transfer from boat to car can be made as readily on the eastern as on the western bank. Such freight business from the South as goes to New England points by rail is transferred at New York, where a bridge is entirely out of the question, and would not be likely to take a circuitous route to avoid the ferry transfer. There is not, anywhere along the river, a local traffic which would pay for the building of a costly structure.

The only traffic which could be relied on to support a bridge, without a diversion of business from older routes which it would take a long time to effect, is in coal, iron and similar freights from Pennsylvania. New England is not to any extent a fuel-producing region, and, aside from the wood which is used in the country districts for household purposes, its supplies of fuel for both manufacturing and domestic purposes are procured from the mines of Pennsylvania. The coast towns and cities have always received their supplies by water, and this business is now so organized that no rail route can possibly carry it more cheaply. There is, however, a large section of the interior to which coal is now carried by rail from the ports on Long Island Sound and the Atlantic Coast, and this section could probably be as well, perhaps better, served by the bridge route. It is mainly on this traffic that the bridge must rely for support until a share of Western business can be diverted from the Northern rail and water routes to the Erie and the Pennsylvania lines. A serious doubt as to whether the traffic over the bridge would be sufficient to pay interest on its cost is the chief reason why it has not been built before.

At present, it seems probable that the bridge will, with proper connections, be a success commercially as well as from the engineering point of view. The building of two or three rival bridges would certainly result in the financial failure of all of them, but a single bridge ought to be able to maintain itself, though it can hardly fulfill the high expectations which some of its projectors seem to entertain of the profits of the enterprise.

The Poughkeepsie Bridge has its rail connections practically still to be made. The single line from the bridge eastward is not now in a condition to do a large business. A short railroad line connecting with the New York & New England Railroad is to be built, and is a necessity. On the western side of the river a line, not very long, but through a hilly and difficult country, must be built to enable any railroad to reach the bridge. At present there is nothing at that end. Not very much new railroad beyond this, but a considerable adjustment and rearrangement of connecting lines will be necessary to secure the desired business.

The plans and construction of the bridge will doubtless furnish interesting topics of discussion to the large number of engineers who will visit it during the American Society's convention early in the present month.

NEW PUBLICATIONS.

REPORT OF THE SECOND ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS: 1887. Champaign, Ill.: published by the Society, Professor A. N. Talbot, Secretary.

THIS report, besides the annual statements of the officers, contains the annual address delivered by the President, Professor I. O. Baker, on the progress of Engineering during the year, and a number of papers read by members. The distinguishing feature of nearly all these papers is their practical nature and directness of application. The subjects treated of include Drainage for Cities; Surveys for Drainage Purposes; Township Boundaries; Perpetuation of Corners; Reservoirs for Mills and Farm Use; Pavements for Small Cities, and others of a similar nature.

Besides a report on general engineering progress, committee reports are presented on Land Drainage and Public Highways; Instruments, Blanks and Records; Sanitary Engineering and Water Supply and on Mining Engineering. Some of these reports are of value; others are hardly up to the standard which might be expected. Something is to be excused, however, to engineers whose time is usually so fully occupied.

BOOKS RECEIVED.

GAS POWER COMPARED WITH STEAM POWER. BY JOSEPH EMERSON DOWSON. London: Published by the Institution of Civil Engineers.

RECENT RESEARCHES IN FRICTION, BY JOHN GOODMAN. London: Published by the Institution of Civil Engineers.

PRESSSURE-RECORDING INSTRUMENTS. BY JARVIS B. EDSON, M. E., New York. This is a reprint of a paper read by Mr. Edson before the United States Naval Institute at Annapolis, at the meeting of March 4, last.

AMERICAN INSTITUTE OF ARCHITECTS; PROCEEDINGS OF THE NINETEENTH ANNUAL CONVENTION. Newport, R. I.: GEORGE C. MASON, Jr., Editor and Secretary of the Institute.

ROYAL ENGINEERS' INSTITUTE, OCCASIONAL PAPERS, VOLUME XI. Chatham, England: Edited by Captain FRANCIS J. DAY, R. E., and published by the Institute. This volume contains several papers of much interest, notably those on Frontier Railroads in India, and on Road-making in Western India.

THE ECONOMIC THEORY OF THE LOCATION OF RAILWAYS: BY ARTHUR MELLEN WELLINGTON. New York: John Wiley & Sons and *Engineering News*. This is a revised and very much enlarged edition of the book with the same title which was published by Mr. Wellington some years ago, and which was much appreciated by engineers. We hope to review the new edition at length hereafter.

THE MOLTENS RESERVOIR: BY CHARLES JOHN WOOD. London; published by the Institution of Civil Engineers.

DREDGING OPERATIONS AND APPLIANCES: BY JOHN JAMES WEBSTER. London; published by the Institution of Civil Engineers. This book includes an abstract of a discussion on the subject, as well as Mr. Webster's paper.

THE OFFICIAL RAILWAY EQUIPMENT GUIDE: Cleveland, Ohio. This is the new name adopted by the publication formerly known as *Sechrist's Hand-Book and Railway Equipment and Mileage Guide*. The new title is certainly more convenient aud less cumbrous than the old one. The *Guide* is an exceedingly useful publication, and must be indispensable to railroad offices.

PROCEEDINGS OF THE ENGINEERS' CLUB OF PHILADELPHIA: VOLUME VI, NO. 2. Philadelphia; issued by the Club. As usual with this Club, the present number of the *Proceedings* contains several papers of value.

REVISTA MENSAL ENGENHARIA E INDUSTRIA: CLUB DE ENGENHARIA, RIO DE JANEIRO, BRAZIL. This is a new monthly publication, issued by the Engineers' Club of Rio de Janeiro, Brazil. It contains the proceedings of the Club and papers presented by the members.

THE TANITE COMPANY'S ILLUSTRATED CATALOGUE OF EMERY WHEELS AND GRINDING MACHINERY. Stroudsburg, Pa.; issued by the Company.

ELECTRIC LIGHT PRIMER; BY CHARLES L. LEVEY. New York; published by the author. This is a brief description of the electric lights chiefly used, with definitions of electrical terms.

JOHNSON STEEL STREET RAIL COMPANY; GIRDER RAILS AND PERMANENT WAY FOR STREET RAILROADS, Johnstown, Pa.

IMPROVED CORLISS ENGINES; BOILERS, SHAFTING AND GEARING; ROBERT WETHERILL & CO. Chester, Pa.

CATALOGUE OF RAILROAD SUPPLIES; CRERAR, ADAMS & COMPANY, Chicago, 1887. This catalogue is probably one of the largest and most nearly complete of its kind ever issued.

CINCINNATI CORRUGATING COMPANY: CATALOGUE. Cincinnati, 1887. This is a catalogue of roofing and building material of corrugated and other sheet metal manufactured by the company.

OBITUARY.

MR. GILMAN TRAFTON died at his residence in Louisville, Ky., May 25. He was for many years Engineer of the Louisville Bridge & Iron Company, but resigned that position a few months ago on account of ill health. He was well known as a bridge engineer and had designed many important works. He had been a member of the American Society of Civil Engineers since 1871.

MR. WILLIAM JACOMB, who died suddenly in London, England, May 25, was a pupil of the late Mr. Brunel and afterward assisted him in several of his works. He had immediate charge of the building of the famous steamship *Great Eastern*. Later he confined himself to railroad work, and for several years past had been Chief Engineer of the London & Southwestern Railway.

SAMUEL GATY, who died in St. Louis, June 9, aged 76 years, made the first casting ever turned out from a St. Louis foundry, built the first engine made west of the Mississippi River, and aided in the construction of the first steamboat, the *Eagle*, accredited to St. Louis builders. He was born in Kentucky and served his time at a foundry in Louisville. In 1828, he went to St. Louis and established the first foundry there, afterward adding a machine shop. In 1862, he retired from that business, but was for a time President of the Ohio & Mississippi, Western Division. He was also interested in other railroads and in mining property.

Contributions.

Rail Sections.

AN esteemed correspondent writes: "I may state that the result of my observations would, I suppose, class me with those who advocate small radii for throat of wheel and upper rail corner. I may venture the opinion that excessive wheel loads also contribute largely to the side-wear of rail and flange. I mean, that when the true curves are found, the wear will still go on.

"As railroads are now organized into departments, the upper corner of the rail forms the boundary between the car and the roadway departments, each managed on an independent basis. If the settlement of the question were assigned to either department, I believe that a satisfactory solution would soon be reached."

To the Editor of the Railroad and Engineering Journal:

REFERRING to the article in your May number regarding rail sections, I could give you diagrams of standard sections on the Atchison, Topeka & Santa Fé Railroad, diagrams and tables of rail-wear and diagrams of wheel-wear, but I refrain from thus occupying your space for, if I comprehend the situation at all, the main question is not what is the best theoretical section either for strength or least wear. We have many good (claimed to be superior) sections in use on our trunk lines, any one of which will do for a train to run over. In my opinion the section to be adopted should be decided upon in the same way as the standard car-wheel tread or section was decided upon, by a majority vote of all interested parties.

The shape of the head is probably all that needs to be standard. The important result is not so much to find a section that will be theoretically a perfect one. Neither is it necessary to get the one that will best suit the majority of roads. The best rail to adopt is the one in common use, which will best *preserve the gauge* in connection with the standard wheel.

The fact that some rail-heads have outward sloping sides, others inward—some ⅜ in. radius on upper corners —others ⅝ in.—and the fact that some roads gauge near top of head (the correct gauging point) while others gauge at the bottom of the head, are the causes for the present variation in widths of the *standard* track gauge of at least ¾ in. in tight gauge, and fully twice that on curves where some roads allow 1 in. (or more) wider gauge, while others keep tight gauge.

The 1⅜ in. variation in rolling-stock gauges and 1¾ in. variation in track gauges are the cause of a large amount of wear and tear on track and rolling-stock, to overcome which should be the first aim in adopting a standard section.

The wheel section already adopted should be consulted and allowable limits of variation should be established.

With the present variations in gauges it is absurd to call our gauge of standard roads 4 ft. 8½ in. We might as well say 4 ft. 8 in. or 4 ft. 9 in.

If we can pick out six of the most common sections we can well afford to take the poorest of the six as a standard rather than to fool away more *expense* in delay.

If we can adopt a rail section *and a gauge* with not more than ⅜ in. total difference between wheel gauge and track gauge, keeping our gauge standard on curves as well as tangents, letting each road narrow its engine-driver tires to suit its own curves, we shall save hundreds of thousands of dollars per annum in repairs of track and rolling-stock, and all of it will not be saved on rails and wheels. My point is simply this: Give us any of the best sections in use, but let the matter of gauging be brought to as fine a point as possible.

H. V. HINCKLEY.

THE GEODETIC WORK IN THE UNITED STATES.

V. THE U. S. COAST AND GEODETIC SURVEY.—CONTINUED.

BY PROF. J. HOWARD GORE.

THE unsettled condition of the political affairs of the country about this time, prevented any further consideration of the Survey project until March, 1811, when Mr. Gallatin requested a friend to ascertain if Mr. Hassler would undertake the mission to London for the instruments. An affirmative answer was at once given, and preparations for the trip begun in the way of making drawings and consulting those in authority regarding the details. On August 25, Mr. Hassler sailed for Liverpool, and the day after his arrival in London, he had a conference with Troughton and other makers. The superior workmanship of Troughton commended itself so highly that he was selected to make the major part of the instruments wanted. This, together with the fact that he was at that time working on the great mural circle at Greenwich, explains the delay to which Hassler was subjected, and for which he has been so frequently and so unjustly censured. This is further shown by a letter received from the Treasury Department in June, of the year following, instructing him to remain in London until the completion of his mission, political charges notwithstanding. A visit to Paris was made to procure books and standards which cost considerable time, the rebellion then in progress making it difficult and very tedious to procure passports. Also the construction of instruments from original design, requiring in some cases the manufacture of the needed patterns and tools, was a more protracted task than was contemplated, so that it was not until December 14, 1815, that the instruments were unpacked and placed in the University of Philadelphia, under the care of Robert Patterson, duly delivered as the completion of the mission.

The plan for putting into operation the survey of the coast was submitted to Mr. Dallas, then Secretary of the Treasury, January 5, 1816, and the approbation was received in return a couple of weeks later. It was not until May, however, that Congress made the requisite appropriation, while the commission as Superintendent was not signed until August 3 of that year. This document was taken from Hassler's scheme previously submitted. It specified, by way of instruction, that the assistants were to be derived from the Corps of Engineers and from the Navy, that the traveling expenses were to be paid by the Government, except in the case of the Superintendent, whose salary of $5,000 a year was to cover his expenses, and that draftsmen were to be employed as their services were needed. Even before his appointment as Superintendent. Hassler had spent several weeks seeking a suitable place for the measurement of a base line, visiting for this purpose, then and later, portions of the New Jersey and Long Island coasts, Hempstead Plains and various places along the Hudson River. The first report, transmitted November 23, 1816, gives a detailed account of this search. The difficulties experienced from wooded marshes and lack of sharp points near the coast impressed him more than ever with the necessity of carrying along a strong chain of triangles back from the shore, with secondary triangles to check the off-shore and in-shore work. During the following spring the reconnoitering was prosecuted vigorously, meeting with success in the way of a suitable site for a base in the valley of the English Neighborhood and Tinively, at the west foot of the North Mountains. Two preliminary measurements of the line were made with a chain constructed for the purpose giving 9,446 meters as the mean, the two results differing very slightly from one another. The more accurate determination was deferred, the time being wanted for the re-erection of signals and the adjustment of instruments. The signals were cones made of sheet tin, about 16 in. high, diameter of the lower base the same, while that of the upper base was 14 in. They proved to answer very well in a morning or evening illumination, in one case being visible from a point somewhat more than 30 miles distant.

As had been expected, the instruments were in great need of adjustment after a space of five years, in which time they had made a long journey over land and water confined in boxes and under unequal pressure and strain of their different parts. It was found that the smaller theodolites had fared better than the larger ones, giving to the latter only the advantage of better seeing with their more powerful telescopes. The following extract from a report of progress written this year shows the accuracy thus early obtained. "The results of my observations have proved very satisfactory in point of accuracy; as far as the preliminary computations have led hitherto the sum of those angles of a triangle, of which all three angles are measured, being within about one second in a mean equal to two right angles; and the distances concluded by various elements agreeing in a mean within 1 ft. in distances from 8 to 20 miles. So that every desirable accuracy is likely to be obtained by the proper combination and reduction of the observations and their accurate calculation, which must be the work of this winter; and the results will, I hope, enable me to begin next summer the detailed survey."

A second, or verification base, was measured in December, 1817, upon the sea shore of Long Island, near the Narrows. The length of this line was found to be 7,753 meters. The results of three different combinations of the triangles carried out upon it, falling all within two-tenths of a meter, were taken as confirmatory of the accuracy of the original base.

As was quite natural, the beginning of a work so vast, in a country almost in its native condition, without trained assistants and with instruments needing trial and adjustment, was a tedious and slow process, so much so in fact that the Secretary of the Treasury wrote to the Superintendent: "For it must not be dissembled that the little progress hitherto made in the work has caused general dissatisfaction in Congress, which, if not removed may lead to a repeal of the law under which you are now acting." In answer to this letter, Hassler gave a detailed account of his operations up to that time, stating how he himself had been up and observing with or before sunrise, that he had worked upon the preliminary computation till late at night; that he had formed 80 triangles, embracing 41 stations, at each one of which he had measured every angle; that two bases had been measured; and that a sufficient number of latitudes and azimuths had been determined to place the work in its proper place on the earth, and give to it its proper direction. These were the results of four months' actual work which caused the dissatisfaction of Congress.

Perhaps, if we could only look deeper, we might find that, while the Secretary of the Treasury has been made to carry the blame, others were instrumental in the passage of the act repealing all former acts relating to the appointment of a civilian superintendent and placing the Survey under the direction of the War Department. We might see in the number of engineer officers left without duty by the peace of 1815 a dissatisfaction with service under a foreigner, and a hope that if the entire work were under their control, it might be so apportioned as to give to each some professional service. This law of 1818 authorized the employment of none but Army and Navy officers for field work. Under the new *regime* some detached surveys were made, but the work lacked harmony, and being executed by different persons and with various methods, it was impossible to unify the results. As a whole, the year's operations were unsatisfactory, and, acting upon the principle that silence would render the shortcomings less conspicuous, the Department under whose direction it was placed, did not, in its annual report, make mention of its rise, growth or decay.

Parenthetically, it may be remarked that, after his summary dismissal, Hassler was employed as Astronomer, on the part of the United States, to the Commission for fixing the boundary, according to the fifth article of the Treaty of Ghent, between the United States and Canada. While acting in this capacity, the English astronomers were so put to shame on account of the inferiority of their instruments that they sent home for better ones, and when received they did not equal those Hassler had designed 10 years before.

From 1819 till 1832 attempts were made from time to time to make a survey of portions of the coast under the direction of the Navy Department; there were also made some surveys of rivers and harbors, together with hydrographic examinations of the coast of a few of the States, but being isolated and without checks or verification they reflected no credit upon the Navy or the country. The desultory work and questionable results caused the Committee on Naval Affairs in 1828 to make inquiry of the Secretary, Mr. Southard, requesting his opinion regarding the character of the operations and the reliability of the charts. He replied that the charts were expensive and unsafe, and recommended a recurrence to the law of 1807. Fortunately, Hassler's presence in Washington about this time, examining and comparing the standard weights and measures in accordance with the act of May, 1830, gave him a better opportunity to explain to those in authority what had been done, what remained to be done and the best way of doing it, so that the law of 1832, reëstablishing the Coast Survey, removed the restriction regarding the sole employment of officers of the Army and Navy, and in August of the same year Hassler was appointed Superintendent. Work was begun in September with the aid of two assistants, but owing to the lateness of the season, operations were limited to the re-erection of signals at the stations used in 1817. In the following year a larger party was put in the field, some to carry on secondary triangulation, others to do detail surveying and sketching while the reconnoissance was pushed in both directions along the coast. The *personnel* of the Survey continued to increase, so that at the end of 10 years there were employed 27 civil assistants and 18 officers of the Navy, with four vessels for off-shore work. In 1834, the Fire Island base was measured with an apparatus of Hassler's own devising; the length was 14,058.9 meters. The principal triangulation was carried from Point Judith to below Philadelphia, in the Delaware, and the secondary, commencing at the same point on the north, covering the sea coast as well as the shores of Long Island and the Delaware, was carried as far south as Capes Henlopen and May, and to Annapolis in the Chesapeake. A reconnoissance had been made in North Carolina, and the site of a base selected from which similar operations should emanate. Four sheets of the large map of New York Bay and harbor were finished, and the reduced sheets of the bay and Long Island were ready for the engraver, together with the whole of Delaware Bay. The soundings of the outer coast had been carried far enough seaward for all practical purposes of navigation. In the whole work the triangulation covered 9,000 square miles, furnishing determinations of nearly 1,200 stations for the representation of 1,600 miles of shore line; 168 topographical maps had been made and 142 hydrographic charts filled up.

The entire cost up to this time, from the beginning, was $881,549, besides about $287,000 for equipments of the naval parties engaged in soundings.

Although the progress so far made was very great, and the expense comparatively slight, the pressing demands of the growing commerce of the country caused many complaints to be heard in Congress against the administration of the Survey, with the text that the slow advance in the work was due to refinements altogether unnecessary for the ultimate purposes of the Survey, and that the practical tangible results were inadequate to the expenditure. With the plea of extravagance, it is easy to attract, if not secure, the attention of Congress, so in the present instance the cries were listened to, and the causes of the clamors were investigated in 1842 by a congressional committee. The scrutiny to which the work was subjected was of an unfriendly character, and the examination was addressed rather to the Superintendent than to the operations under his direction. The result was a complete vindication of the methods then in use.

A proviso was attached to the appropriation bill of 1843, directing that the Survey be thereafter prosecuted in accordance with a plan of reörganization to be prepared by a board of officers, consisting of the Superintendent, two first assistants, two naval officers in charge of hydrographic parties and four officers of the corps of engineers. This board convened on March 20, 1843, and in their plan then adopted they set their seal of approval upon the methods already employed, and reared to Hassler his greatest monument by taking the original scheme as the basis of reörganization and the guide to be followed in the further execution of the Survey.

The worry of this examination, the continuous trouble with the auditing officials and the numerous and severe exposures to which, in his enthusiasm, he subjected himself, so affected his physical nature that death came to his relief in November, 1843.

A Large Lake Steamer.

THE new steamer *Aurora*, now nearly completed at Cleveland, O., for the grain and ore trade on the upper lakes, is an excellent example of the large carriers now used in that trade. Her capacity is 3,000 tons of freight, and she is expected to make 14 miles an hour under steam. The *Aurora* is owned by Captain Wm.

Mack, Mr. John Corrigan and others, and has been built under the supervision of Captain Mack.

The *Aurora's* length of keel is 293 ft., and she is 312 ft. over all. The breadth of beam is 42 ft. outside everything. The molded depth in the shoalest place is 24 ft. 6 in.; shear, 6 ft., the after depth being 30 ft. 6 in.

The frames are 6-in. flitch, double, with extra long floors, from bilge to bilge without a break, 19 in. at the seat and 17 in. at bilge, 9 in. at top height. The keel is 9 × 16 in.; main keelson, 16 × 16 in.; sister keelsons, 16 × 16 in.; 12 floor keelsons, 6 on each side, 15 × 16 in., bolted through every frame with five 1-in. bolts; the frames are 21-in. centers. The keelsons are bolted through into keel with 1¼, and garboard with 1¼-in. bolts; the rider keelsons are 17 × 18 in., bolted clear through with 1¼-in. iron. Garboard is 8 in., next 7, and bottom all 6 in. white-oak. Top sides are 5 in., except three strakes of 7 in. let into frames. The ceiling is all 6 in. from last big keelson. There are five strakes commencing with 11 in. and diminishing to 6 in. at ceiling, going up 6 in. to main deck, then 7 strakes 7 in. thick are notched into frames 1 in., all edge-bolted, 2 bolts between frames, with 1-in. iron shelf-pieces under main deck, 6 in. × 3 ft., bolted through inside of vessel; upper shelf under spar deck the same. The deck is of 3-in. white pine. There are 8 hatches to handle cargo. There are four masts, with standing gaffs to handle cargo; no sails.

There will be three steel arches, two on the outside, the lower arch catching hold of the extreme corner forward and going up high amidships, then ending at the extreme lower corner aft. This arch is of steel, 1 in. thick and 12 in. wide; the length is 310 ft. The next is 10 ft. above the first, and is of the same size. A steel cord catches the stem on one side and goes around the vessel without a break to the stem again on the other side; this steel cord is 1 × 12 in. and is 635 ft. long. The other arch is on the inside, abreast of the first one, and is put in so that bolts (1½ in.) go through outside plank, outside arch, frames, ceiling inside and through this inside arch, thus fastening by riveting together the whole mass; there are 4 bolts in every frame, through and through. All fastening is the best 1-in. iron. Batten planks are bolted on with 4 bolts and 2 spikes in every frame, and top sides with 2 bolts and 2 spikes in every one. The top strake is 7½ and 8 in.

There are 1,300,000 ft. of lumber and 350 tons of iron used in the construction of this vessel. Her model combines great displacement with fine ends.

For handling cargo the ship has Emerson steam winches forward, capstan and steam capstan aft. She is provided with Williamson Brothers' best steering gear.

The boilers are on the main deck. The cabins are aft the boilers and forward of foremast.

The engines of the *Aurora* are of the triple-expansion type with latest improvements, and were illustrated in the June number of the JOURNAL, pages 253 and 254. The engines are built by the Cleveland Shipbuilding Company, and the hull by Murphy & Miller, of Cleveland, Ohio.

LOCOMOTIVE FOR THE ANTOFOGASTA RAILROAD OF CHILI.

THE accompanying illustration represents a locomotive of 30-in. gauge built for the Antofogasta Railroad of Chili by the Baldwin Locomotive Works in Philadelphia. The dimensions of the engine are as follows:

WEIGHT AND GENERAL DIMENSIONS.

Gauge of road	2 ft. 6 in.
Total weight of locomotive in working order	51,880 lbs.
Total weight on driving-wheels	36,190 lbs.
Total wheel-base of locomotive	20 ft. 9 in.
Distance between centers of driving-wheels	5 ft. 8 in.
Distance from center of cylinders to center of main drivers	9 ft. 5 in.
Length of main connecting-rod between centers	5 ft. 1 in.
Transverse distance between centers of cylinders	6 ft. 1 in.

CYLINDERS, VALVES, ETC.

Diameter of cylinder and stroke of piston	13 × 20 in.
Horizontal thickness of piston over piston-head and follower-plate	4¾ in.
Kind of piston packing	Steam
Diameter of piston-rod	2¼ in.
Size of steam ports	12 × 1 in.
Size of exhaust ports	12 × 2 in.
Greatest travel of slide-valves	4¼ in.
Outside lap of slide-valves	1/16 in.
Inside lap of slide-valves	1/32 in.
Lead of slide-valve in full stroke	1/16 in.
Throw of upper end of reverse lever	3 ft. 1 in.
Sectional area of opening in each steam pipe	12.5 sq. in.

WHEELS, ETC.

Diameter of driving-wheels outside of tires	48 in.
Diameter of truck wheels	26 in.
Size of driving-axle journals, diameter and length	6 × 7 in.
Size of truck-axle journals	4 × 6 in.
Size of main crank-pin journals	3½ × 3½ in.
Size of coupling-rod journals	3 × 3 in.
Length of driving-springs, center to center of hangers	2 ft. 8 in.

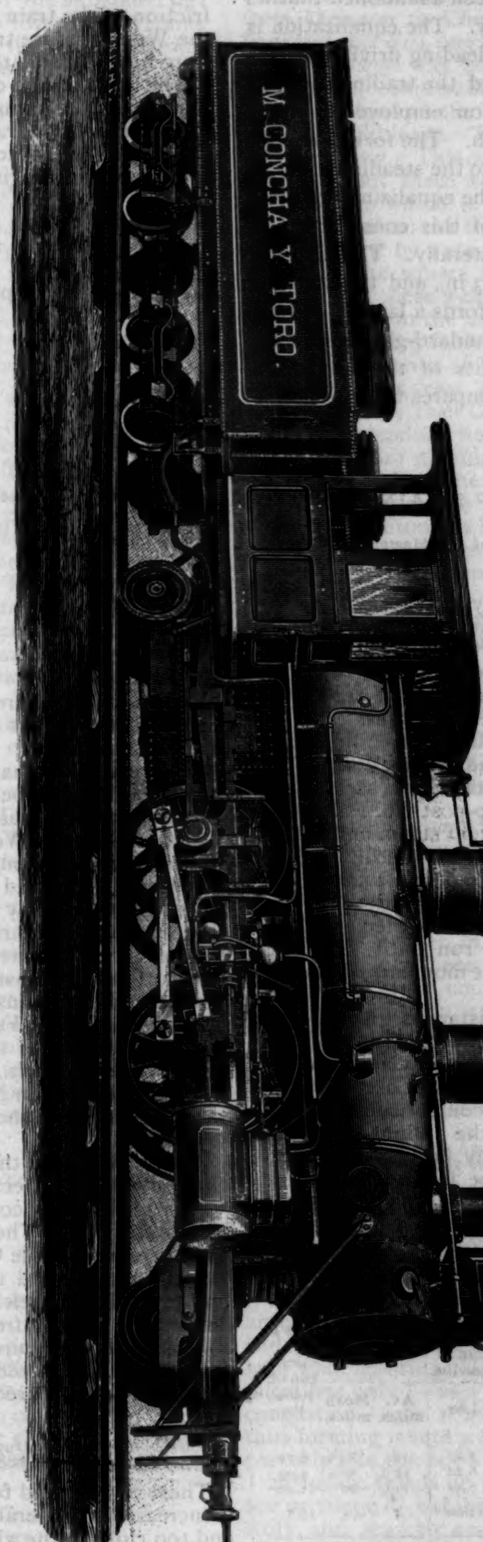
BOILER.

Description of boiler	Straight top, 1 dome.
Inside diameter of smallest boiler ring	42 in.
Material of barrel of boiler	Steel.
Thickness of plates in barrel of boiler	⅜ in.
Kind of horizontal seams	Lap seams, double riveted.
Kind of circumferential seams	Lap seams, single riveted.
Material of tubes	Brass.
Number of tubes	109.
Diameter of tubes, outside	2 in.
Distance between centers of tubes	2⅝ in.
Length of tubes over tube-plate	10 ft. 6 in.
Length of fire box, inside	50 in.
Width of fire-box, inside	32 in.
Depth of fire-box from under side of crown-plate to bottom of mud ring	57 in. front. 56 in. back.
Water spaces, sides, back and front of fire-box	2½ × 2½ × 3½ in.
Material of outside shell of fire-box	Steel.
Thickness of plates of outside shell of fire-box	⅜ in.
Material of inside of fire-box	Copper.
Thickness of plates in sides, back end and crown of fire-box	½×½×½ in.
Material of fire-box tube-plate	Copper.
Material of smoke-box tube-plate	Steel.
Thickness of front and back tube-plates	½ × ½ & ¾ in.
Crown-plate is stayed with	Rad. stays.
Diameter and height of dome	24 × 21 in.
Working steam-pressure per square inch	130 lbs.
Kind of grate	Plain cast-iron.
Width of bars	¾ in.
Width of openings between bars	¾ in.
Grate surface	11 sq. ft.
Heating surface in fire-box	69 sq. ft.
Heating surface of the outside of tubes	594 sq. ft.
Total heating surface	663 sq. ft.
Kind of blast-nozzle	Double.
Diameter of blast-nozzles (three sizes furnished)	2 × 2¼ & 2½ in.
Smallest inside diameter of smoke-stack	13 in.
Height from top of rails to top of smoke-stack	13 ft.
Smoke-box	Straight.

TENDER.

Weight of tender empty (actual)	25,000 lbs.
Weight of tender with fuel and water	49,000 lbs.
Number of wheels under tender	8.
Water capacity of tank (in gallons of 231 cubic in.)	2,400 gals.
Coal capacity of tender or fuel bin	4 tons (of 2,240 lbs).

In the construction of this engine the problem presented was to build an engine of the exceedingly narrow



LOCOMOTIVE FOR THE ANTOFOGASTA RAILROAD OF CHILI.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

gauge of 30 in., having a weight of about 25 net tons, driving-wheels 48 in. diameter, and sufficient lateral stability to run at a speed of 30 to 45 miles an hour. To meet these requirements the placing of the frames outside of the driving-wheels was resorted to, a practice by no means new, but one which has so long been abandoned that its revival may be considered a novelty. The equalization is between the leading truck and the leading driving-wheels and between the trailing truck and the trailing driving-wheels. The system of equalization employed is sufficiently indicated by the photograph. The forward truck is made side-bearing to contribute to the steadiness of the engine and prevent its riding on the equalizing fulcrums as on a knife-edge. The result of this construction is that the engine is perfectly steady laterally. The distance from center to center of frames is 43 in., and the distance from center to center of springs affords a lateral, flexible base almost as great as that of a standard-gauge locomotive. This construction also admits of the maximum width of fire-box, 32 in., which compares favorably with standard-gauge practice.

THE RESISTANCE OF TRAINS.

[From the report of the Brake Committee of the Master Car-Builders' Association on the Burlington tests.]

THE following figures give briefly the results of the No. 7 special tests made to determine the frictional resistances of the various trains. The trains were composed of 49 or 50 empty cars with dynamometer and way-car, and American type engine and tender. The track and rails were in good condition and the wind light.

Each train was tried once on a slightly descending tangent, and once on a curve, situated on an average descending grade of 50.6 ft. per mile. The resistance was ascertained on the tangent by running up to stop-post No. 1 at about 20 miles per hour, and then shutting off steam and allowing the train to run until it came to a stand-still.

The resistance on the combined grade and curve was ascertained by running the train up to stop-post No. 3 at a low speed (about 5 miles per hour), and then shutting off steam, and allowing the train to run until stop-post No. 4 was reached. The speed at the moments of passing each stop-post was carefully noted.

It will thus be seen that the resistances given below include not only the resistance of the cars, but of the engine running without steam. This is probably greater per ton than that of the cars, but the weight of the engine (about 40 tons) is so insignificant in comparison with that of the cars (700 to 800 tons) that the influence of the engine in running without steam may be neglected, and the resistances given may probably be taken to represent fairly the resistance of new empty cars:

1887.

Pattern of cars.	Brake.	Tangent. Speed. Average miles.	Tangent. Speed. Mean miles.	Tangent. Res't'ce lbs. per ton of 2000 lbs. Lbs.	Curve. Speed. Av. miles.	Curve. Speed. Mean miles.	Curve. Res't lbs. per ton of 2,000 lbs.
Penn.	Westing'e.	15	15	5.87	19	23¼	8.72
Ill. Cent.	Carpenter.	14½	15	6.22	15¾	22¼	9.09
C. B. & Q.	Eames.	11½	14¼	7.51	13¾	20	11.00
St. Jo. & St. Louis.	Hanscom.	11½	15	12.00	4	4	19.8
Average		13¼	15	7.90	16¼	22	9.60

In making this average, the Hancom results on the curve are excluded, as they are not based on sufficient data to be trustworthy. The "mean speed" is the average of the squares of the speeds.

The cars were new, and were tried empty. The Pennsylvania cars were lubricated with dope. The Eames cars, when loaded, after these trials, gave trouble from hot boxes. The great resistance of the Hanscom train was caused by the brake-shoes binding on the wheels. The brake-shoes on the Eames trains were also in some cases very close to the wheels, and apparently affected the friction of the train on the curve. The brake shoes on the Westinghouse train were hung inside; all the others were hung outside the wheels.

The trials on the curve were made between stop-posts Nos. 3 and 4. About half the total distance is on a 2°, 40′ curve (2,149 ft. radius) extending over nearly a quarter of a circle (80° 40′ 10″) and the remainder of the distance is on curves averaging about 1°, or say about 6,000 ft. radius.

The results given in similar trials of brake trains over the same ground in 1886 were as follows; the trains were, however, composed of 25 cars, 12 loaded to their full capacity and 13 empty:

1886.

Pattern of car.	Brake.	Tangent. Average speed miles.	Tangent. Rest'n'ce lbs. per ton of 2,000 lbs.	Curve. Average speed miles.	Curve. Rest'n'ce lbs. per ton of 2,000 lbs.
C., B. & Q.	Westinghouse	20½	4.32	26¼	6.07
I., D. & S.	Eames	16¾	6.84	21¾	9.42
Lehigh Val	Widdifield & Button	16¾	6.84	21¾	9.42
St. L. & San Francisco...	American	11½	8.50	21¼	8.94
Average 1886..................		16¼	6.62	22¾	8.46
" 1887....................		13¼	7.90	16¼	9.60
Average of both years.........		14¾	7.26	19½	9.03

The Committee are indebted to Mr. A. M. Wellington for the calculations giving the results of the trials in 1886.

The results for the two years agree fairly well. The average difference between the resistances on the tangent and on the curve was 1.84 lbs. in 1886 and 1.70 lbs. in 1887. One train of cars (Westinghouse, 1886) gave a resistance of only 4.32 lbs. on the tangent, while another train (Hanscom, 1887) had a resistance of 12.00 lbs. per ton on the tangent, or nearly three times that of the Chicago, Burlington & Quincy cars in the lighter running train. This difference was apparently principally due to the brake-shoes rubbing against the wheels, and was equal to a constant grade against the train of 20 ft. per mile. In running from New York to Chicago, 1,000 miles, the extra resistance would be thus equivalent to surmounting an elevation of 20,000 ft., or more than the height of the highest mountain in North America. The importance of keeping the brake-shoes clear of the wheels is thus very evident.

In the 1886 trials the Chicago, Burlington & Quincy, the Indianapolis, Decatur & Springfield, and the Lehigh Valley trains, were composed of cars that had been running some time. The St. Louis & San Francisco cars cars were new. The Chicago, Burlington & Quincy cars (Westinghouse) had the brakes hung from the trucks and inside the wheels. All the other cars had the brake-shoes hung outside from the body.

The following figures, based on the average results obtained in 1886 and 1887, show the increased friction on the curve as compared with the tangent.

	Increase lbs. per ton.
Shoes hung from the truck and inside the wheels............	2.30
Shoes hung from the body and outside the wheels...........	2.84

These results tend to show that the resistance on curves is increased considerably when the shoes are hung outside and too close to the wheels. When the truck swivels, the shoes, being hung from the body, are lifted and brought closer to the wheels by the greater inclination of the hangers. When the shoes are hung from the trucks no such action occurs, and the shoes remain the same distance from the wheels, whether the car is running on a tangent or on a curve.

The fact that outside-hung shoes rub more forcibly against the wheels on curves, is not only shown by the figures given above, but was also observed when the trial trains were being hauled over frogs and curves in the yard at West Burlington.

The size of journal bearing has, doubtless, an important influence on the friction of trains, and the subjoined figures give the sizes of the journals in three of the trains tried at the 1887 tests, together with the weight of each car, empty, and loaded to its full marked capacity, and the resultant load per square inch on the journals. The bearing area of the journal is assumed as the length and diameter multiplied together:

Cars.	Journal length and diameter.	Weight of car.		Pressure per sq. in. on journal.		Friction tangent.
		Empty.	Loaded	Empty.	Loaded	
	Inches.	lbs.	lbs.	lbs.	lbs.	lbs.
Pennsylvania	8 × 4	30,577	90,577	119	354	5.87
Illinois Central	7 × 4	27,351	67,351	122	301	6.22
C., B. & Q.	7 × 3¾	25,509	65,509	121	312	7.51

As the frictional resistance given was obtained with empty cars, where the load per square inch on the journal is practically identical, the variation found in the resistance is due to other causes than insufficient bearing surface. The highest amount of friction was shown in 1887 by the Chicago, Burlington & Quincy cars, which in 1886 showed the least. In both years the cars were of the same design, but in 1887 the cars were new, whereas in 1886 they had run over 10,000 miles. The difference was, therefore, probably due to less accurate fitting and workmanship as compared with the Pennsylvania and the Illinois Central cars, which were also new, but showed, respectively, 1.64 and 1.29 lbs. per ton less friction than the Chicago, Burlington & Quincy cars. These differences, insignificant as they may appear, would, in running 1,000 miles, necessitate an extra amount of haulage power equivalent to surmounting summits 4,330 and 3,415 ft. high respectively, or greater than that of any line between the Mississippi and the Atlantic. The importance of good fitting is further shown by the Chicago, Burlington & Quincy cars running hot when loaded after the resistance tests.

The Pennsylvania and the Illinois Central cars were built at the company's shops, and the Chicago, Burlington & Quincy cars were built by a contractor.

Your Committee believe from these experiments that the following figures represent the frictional resistance of long trains of freight-cars, in good repair, running over a track in good condition, the weather being fine and warm and the wind light. The resistance appears to be constant at speeds of from 12 to 25 miles per hour, and does not appreciably increase with an increase of speed within these limits:

Frictional resistance, lbs. per ton of 2,000 lbs. Speeds 12 to 25 miles per hour.

	New cars. lbs.	Old cars. lbs.
On tangent	8.00	6.00
On 3° curve	10.50	8.30

Good lubrication and carefully fitted boxes and journals may, with cars that have been running some time, decrease this resistance to a minimum of 4 lbs. per ton on the tangent, while brake-shoes rubbing against the wheels, and other unfavorable conditions, may increase the friction on the tangent to 12 lbs. per ton, and to considerably more on curves. The use of outside-hung shoes seems to increase the resistance on curves when the shoes are very near the wheels.

Natural Gas in Kansas.

THE last report of the Kansas State Board of Agriculture contains an article by Mr. Robert Hay, of the United States Geological Survey, on Natural Gas in Eastern Kansas, which contains the fullest statement regarding the history and extent of the oil and gas regions of that State thus far given to the public. The history of its development is similar to the history in other places. Gas has been found in prospects for oil, and has been developed from surface indications—actual escapes from the soil or rocks—which have been known for long periods. Prof. Mudge, in his report for 1864, states that petroleum, both as oil and bitumen, is found all down the eastern tier of counties from Atchison to Cherokee. A boring of 300 ft. on the banks of the Wea, one mile from Paola, was made in 1874. In 1882, a well was bored on the Westfall place, which gave gas in considerable quantity. The driller, Mr. Warner, then formed the Kansas Oil & Mining Company, under an old lease. This has been changed to the Paola Gas Company. This company has bored some wells about the town, but three wells on the Westfall place are the sources from which it is now supplying gas as an illuminant and fuel to the town of Paola, over seven miles distant. Tested by a steam-gauge, the gas has a pressure of 66 lbs. to the square inch. The depths at which gas is obtained in these wells varies from 288 to 304 ft. Fort Scott has begun the use of natural gas, and has struck it in a well yielding four barrels per day. Southwest of that town, on the banks of the Marmaton River, gas has been escaping for at least a quarter of a century. The Fort Scott Economy Fuel Company, of which Major Knapp is the Superintendent, has drilled four wells, three of which are yielding an abundant supply of gas. The three productive wells form the apices of a triangle nearly equilateral, whose sides are just under 700 ft. in length. The distance from town is little, as the farm abuts on the city boundaries. Mains have been laid, and the gas is now in use in Fort Scott hotels, private houses, etc. At Wyandotte, or in what is now Kansas City, Kan., there are three wells of which the gas is being utilized—one at a flour mill, one at a planing mill and one at the pressed brick works. At the two former, the gas is turned into the furnace under the steam boiler and is estimated to save from 10 to 20 per cent. of the coal. At the brick works, it is used in the same way. Another well at Wyandotte is blowing off gas and some oil which are not utilized at all. There are also wells at Iola, La Cygne, Girard and Independence.

Gas in small quantities has been noticed elsewhere, and oil has similarly been found as far west as Manhattan, and many towns are now prospecting for gas and oil. Ottawa is about to begin, and a company has been formed for the purpose at Wichita and at Quenemo.

Over the border, in Missouri, oil and tar springs and wells have long been known. There is a gas well, not utilized, in Vernon county, 14 miles east of northeast from Fort Scott, and 6 miles north of Deerfield, and in Kansas City there are several, some of which are utilized.

A New Method of Making Tubes from Solid Bars.

[Paper read before the American Society of Mechanical Engineers by George H. Babcock, of New York.]

WE have all heard of the Irishman's method of making a cannon by "taking a hole and pouring melted iron around it," but it has been reserved for a German actually to do a similar, or apparently, an even more difficult thing—to take a hole and force a bar of wrought-iron or steel around it! We are familiar with the process of drilling and punching for perforating metals, but here comes a man who, ignoring all such makeshifts, by "external applications only"—as a skillful physician treats an internal congestion—rolls a hole into the middle of a solid rod, thus forming it into a tube! What makes the hole? Apparently like the boy's whistle, it "does itself."

Seriously, this is no joke. The specimens which I have the privilege of exhibiting to the Society tell their own story, and scarcely need the evidence of the eye witness who saw them made, and who loaned them for this purpose. As yet, the process has not been worked in this country, but it is in practical operation in Germany. It is the invention of two brothers named Mannesmann, of Remscheid, and the *modus operandi* is as difficult to understand and explain, as was Giffard's injector or Bohnenberger's gyroscope.

The apparatus necessary to effect the result consists of two rollers slightly conical, the axes of which are in different planes—or form two lines in a twisted surface—their nearest approach being at or near the bases of the cones. The surface of the cones may be threaded in such a way that they tend to draw a body rolling between them toward their larger ends. The bar to be operated upon should be approximately round, and its end is to be inserted while hot between the cones, its axis being intermediate at all points to the axes of the rollers. The action of the cones is to draw out and twist the bar, during which operation a hollow forms in its axis, and when the bar emerges, it is a tube with a somewhat rough but approximately cylindrical and concentric bore, the surface of which shows a decided twist.

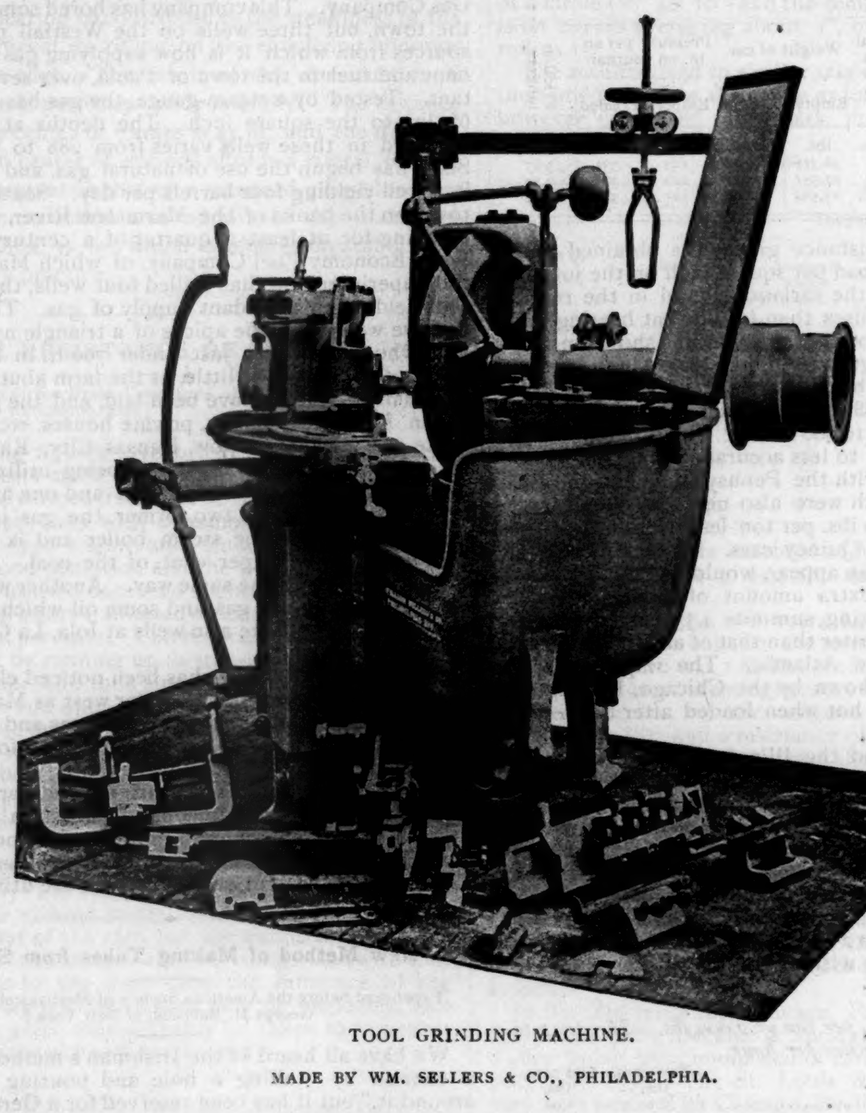
Among the exhibits is a bar which was drawn down at each end before going through the mill, so that no action took place at these ends. This bar, after cooling, was broken, and shows conclusively by the color and character of the bore, that no tool and not even the air touched it during the operation, the interior having the same appearance as the fracture.

The tubes thus formed are applicable directly for some purposes, but by a proper formation of the rolls behind the bases of the cones, or additional pairs of rolls, with suitable mandrel or mandrels, this tube may, at the same heat, be expanded and finished into a regular weldless boiler tube or gas pipe; or this may be done at a separate operation.

That the metal is not harmed by this rather rough handling may be inferred from specimens of tubes, which have undergone operations of expanding, flanging, flattening, etc., which would try the temper and quality of any respectable tube. Brass and copper tubes made by the same process are also shown.

THE SELLERS TOOL GRINDER.

EVERYONE who has ever had experience in conducting a machine shop knows how much time is taken up in grinding the cutting tools used in the lathes, planers and other machine tools; and knows also the difficulty experienced in securing anything like uniformity in the shapes of those tools, not only from the practical difficulty of making uniform shapes in the ordinary way of grinding, but also from the variety of ideas prevailing among the workmen.



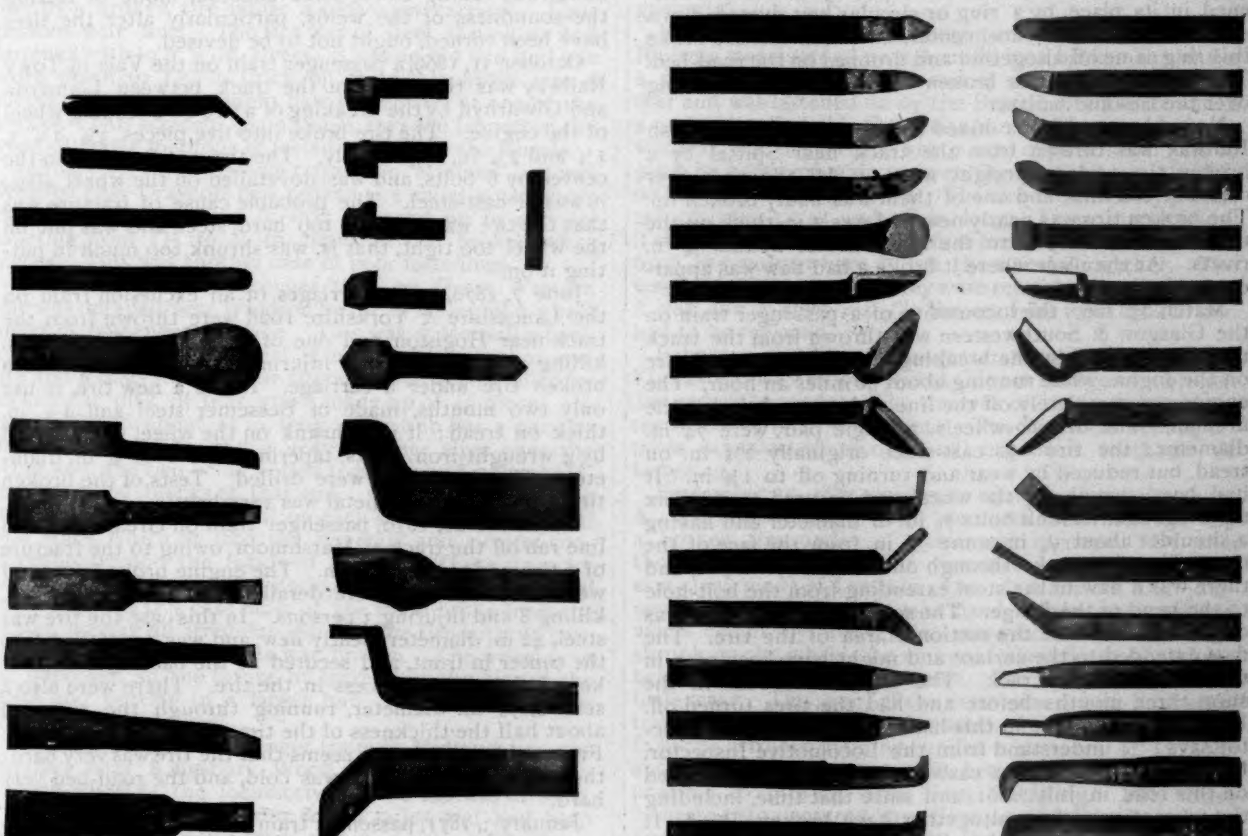
TOOL GRINDING MACHINE.

MADE BY WM. SELLERS & CO., PHILADELPHIA.

The accompanying illustration shows a grinding machine now in use in the shops of William Sellers & Co. in Philadelphia. It is the result of a gradual evolution and its present perfected form is due to a recognition of the difficulties above referred to and a determination to meet them in the best practicable way. In its present form the machine is capable of a very wide range of work, grinding and sharpening cutting tools of almost every shape that can possibly be needed. Some of these shapes are shown in the engravings printed herewith

and a still greater number might be added, were there space to give them.

The machine, as shown, is arranged with a grinding-wheel mounted in a cast-iron frame forming a large tank provided with a pump for flooding the tool with water while being ground, and with suitable shields to prevent throwing water on the working surfaces, the floor or the operator. It has slide rests, by which a vertical and two horizontal motions at right angles with each other, can be imparted to the tool-holding chuck. This machine is adapted to grind all the faces of almost any kind of lathe, planer, slotter or shaper tools. It will grind all the faces of a tool whose cutting edges are formed by the intersection of plane faces, without altering the position of the tool in the chuck. The chuck can be rotated in two



planes at right angles with each other, the exact amount of rotation being indicated by graduated circles and verniers, so that any desired angle of tool or of clearance can be accurately obtained. Means are provided by which any sample tool, whether ground by hand or otherwise, can be used as a template for grinding a "former-plate" to be afterward used for the reproduction of the shape of this sample tool.

With the machine are: 1. A chuck by which any desired curved face for roughing tools can be ground with any desired clearance. This operates in connection with a former-plate to determine the shape of the curve, and this same chuck is used without a former-plate for grinding round-nose tools. 2. A holder by means of which the base of any tool or the side on which it rests, can be readily ground to a plane surface. 3. A diagram giving the shapes of 56 different kinds of plain face tools, together with their angles and the position of the chuck when grinding them. 4. A diagram showing nine different shapes of either right or left hand tools and a former-plate for grinding them. This diagram gives the top-rake and clearance of seven sizes of tools from ½ in. to 2 in. of each standard shape, or 63 in all. These diagrams are those used in the Sellers Works and are the result of experience and experimenting; they can, of course, be modified to suit those whose ideas may differ. 5. A table of circular tools, from ⅛ in. to 2¼ in. diameter, which the machine grinds perfectly.

A feature of the machine is the shape of the face of the stone, as seen in the engraving. The stone is so adjusted that if the faces wear unequally it can be lifted off and reversed by merely taking a nut off from the conical bearing and using the small crane attached to lift the cover off and move the stone.

The machine does not require the services of a skilled machinist to run it; an intelligent laborer can quickly be taught the various adjustments required, and the work can then be done with far more certainty than by skilled labor in the old way. Very quick work can be done, and the grinder at the Sellers Works has treated 350 cutters in a day.

Besides the advantages already alluded to it may be added that, under the system in use at those works, there has been a considerable reduction in the stock of tools which it is found necessary to carry. In the case of thread cutters and special tools the saving of time and in securing uniformity has been very great. It may also be added that the use of approved forms of cutting tools results in a reduction of the power required to drive machines in use.

BREAKAGE OF WHEELS AND TIRES ON BRITISH RAILROADS.

(*Continued from page 259.*)

WE continue below the record of accidents on British railroads from breakages of wheels and tires, which was begun in the June number of the JOURNAL, and the purpose and object of which were there explained. The record then closed with the year 1864, and is now taken up from that point.

ACCIDENT REPORTS.

March 21, 1865, express train on Great Western Railway was derailed near Goring by the breaking of a tire under a passenger car. The train ran over 5 miles before the engine-driver saw that something was wrong and put on the brakes. The tire gave way at the weld, which was very defective, and opened out some 13 in. It was fastened in its place by a ring or circular key riveted down over the rim of the wheel center, but when the tire broke this ring came off altogether and dropped on the road-bed. The wheel center was broken to pieces by hammering over the ties and ballast.

November 12, 1866, a mixed train on the North British Railway was thrown from the track near Spittal by a broken tire under a freight wagon. All the passenger cars left the rails, and one of them was badly broken up. The broken tire was nearly new and was 2 in. thick on the tread; it was fastened to the wheel center by four ¾-in. rivets. At the place where it broke a bad flaw was apparent in the iron.

March 23, 1867, the locomotive of a passenger train on the Glasgow & Southwestern was thrown from the track near Kirkconnell by the breaking of a driving-wheel tire on the engine, while running about 40 miles an hour. The engine ran completely off the line and upset, injuring the fireman. The driving-wheels, a single pair, were 74 in. diameter; the tire was cast-steel, originally 2⅛ in. on tread, but reduced by wear and turning off to 1¼ in. It had been shrunk on the wheel and secured to it by six tapering, countersunk bolts ⅞ in. in diameter and having a shoulder about $\frac{1}{16}$ in. some ¾ in. from the face of the tire. The tire broke through one of the bolt-holes, and there was a flaw in the steel extending from the bolt-hole to the bend of the flange. The solid metal remaining was only about one-half the sectional area of the tire. The flaw extended to the surface and might have been seen in the form of a fine crack. The engine had been in the shop three months before and had the tires turned off. In this case, the first in this list of steel tires, the Inspector says: "I understand from the Locomotive Inspector, Mr. James Stirling, that cast-steel tires were introduced on this road in July, 1861, and since that time, including the present case, four altogether have broken. * * It is apparent, from what has happened on this line since cast-steel rolled tires were introduced in 1861, that some more efficient mode of fastening such tires to the wheels than has been hitherto adopted by this company is necessary for safety. There are many methods well known, which might be adopted, free from the very obvious defect, which is inseparable from the process, of materially weakening the tires by drilling bolt-holes through them, and I cannot think that any railway company is justified in fastening tires to wheels by such a process. If, however, it be contended that the drilling of such holes does not render the tire more liable to break when it has been, as in this instance, reduced to about one-half its original thickness, it is quite evident that a much larger number of bolts should be made use of to prevent tires from flying off the wheels when they do break under such circumstances as have been detailed respecting this accident."

November 27, 1868, a passenger train on the Great Eastern Railway was thrown from the track by the breaking of a tire on a trailing wheel of the engine. The tire broke into four pieces, respectively 1 ft. 4 in., 2 ft. 7 in., 7 ft. and 7 ft. 3 in. long. One of the broken pieces threw off a carriage, injuring three passengers. The tire was Krupp steel, had been running 5 years and had been turned down to about 1¼ in. on the tread. It was fastened on the center by hammering down the rim on wedge-shaped keys. In this case, one of the hammered portions of the rim gave way, allowing a key to fall out, and the tire to begin working; this was probably followed by the shifting of the tire. The Inspector does not consider this method of fastening tires a good one.

November 2, 1868, an express train on the Northeastern Railway was derailed near Hunslet by the breaking of the tire on a leading wheel of the engine. The tire broke at the weld and came off the wheel altogether; it was of wrought-iron, originally 2¼ in. thick, but reduced to 1⅝ in. by turning and wear. It had run 14,285 miles before being turned and 1,864 miles since. It was held to the wheel-center by six ⅞-in. tap-bolts, all of which broke off close to the inside of the tire. The weld was a very imperfect one. In this case the Inspector says: "The question naturally arises whether, so long as welded tires fastened only by bolts continue to be used for the wheels of railway rolling stock, some effectual mode of testing the soundness of the welds, particularly after the tires have been turned, ought not to be devised."

October 31, 1869, a passenger train on the Vale of Towy Railway was thrown from the track between Llanwrda and Glwnrhyd by the breaking of a tire on a leading wheel of the engine. The tire broke into five pieces, 3¾, 2¼, 3, 1¼ and 2¼ ft., respectively. The tire was fastened to the center by 6 bolts, and was dovetailed on the wheel also; it was of cast-steel. The probable cause of fracture was that the tire was made of too hard steel, and was put on the wheel too tight, that is, was shrunk too much in putting it on.

June 7, 1870, seven carriages of an excursion train on the Lancashire & Yorkshire road were thrown from the track near Hoghton, and one of them went over a bank, killing 2 passengers and injuring 27. The cause was a broken tire under a carriage. It was a new tire, in use only two months, made of Bessemer steel and 1¾ in. thick on tread; it was shrunk on the wheel and secured by 4 wrought-iron rivets, tapering from 1 to ¾ in. diameter. The rivet holes were drilled. Tests of the broken tire showed that the metal was very brittle.

December 26, 1870, passenger train on Great Northern line ran off the track at Marshmoor, owing to the fracture of a tire under a brake-van. The engine broke loose and went on, but 6 cars were derailed and 2 badly wrecked, killing 8 and injuring 3 persons. In this case the tire was steel, 42 in. diameter, nearly new, and was dovetailed into the center in front, and secured at the back by 8 clips or keys fitting into a recess in the tire. There were also 4 screws, ⅞ in. diameter, running through the rim and about half the thickness of the tire. It broke in 6 pieces. From evidence taken it seems that the tire was very hard; the weather at the time was cold, and the road-bed very hard.

January 3, 1871, passenger train on Midland Great Western (Ireland) was derailed near Oranmore by broken tire under a passenger carriage. The tire broke in two places, a piece 18 in. long being thrown completely off the wheel. No flaws were found. The tire was iron, and was fastened to the wheel by Cabry's patent, one edge of the tire being grooved and fitted on to the outside of the rim of the wheel-center, and the lap on the outside of the tire being hammered down over the inside edge of the rim.

January 5, 1871, passenger train on London & Northwestern was derailed at Holme station, wrecking several carriages, injuring the guard and 5 passengers. The accident was caused by the breaking of a tire under a brake-van. An extensive flaw was found in the weld (where the tire broke) which appeared at the surface as a slight crack. The tire was originally 2 in. thick, but had been worn and turned down to $1\frac{5}{16}$ in. A second break was through a bolt-hole. The Inspector's report says: "The tire was of iron of good quality, and fixed on the inner rim of a wrought-iron wheel having 9 spokes, by means of 5 conical-headed countersunk wrought bolts ¾ in. diameter, with screw-nuts on the inside of the inner rim or sole of the wheel-center. * * The London & Northwestern and the Caledonian companies have for many years used Mansell's wheels, and I am not aware that any

case has arisen in which a tire fastened on by this method has flown. * * This accident points out conclusively that wheels with tires fastened on as this one was should not be run at all on passenger trains. It is certain that the public traveling on railways in these carriages are subjected to increased risk from this cause in very severe weather; no matter whether the liability to fracture be due to the rigidity of the road-bed, to the greater strain on the tire by its contraction from frost, to the possibility of its being more brittle in frosty weather, or to combined action of all these causes. The increased risk is certainly incurred, and it is high time—10 years since this risk was first made clearly apparent during the winter of 1860–61, and the means of avoiding it clearly pointed out by the officers of the Board of Trade—that it should be incurred no longer."

January 5, 1871, passenger train on the Manchester, Sheffield & Lincolnshire line was derailed near Huntingdon by a broken tire under a passenger carriage. Four persons were hurt. The tire was of steel, shrunk on and fastened with four ¾-in. rivets; it was an old tire, and was worn down to 1⅝ in. thick on tread. It broke into 6 pieces. There was a slight flaw perceptible at one of the breaks. This accident again shows, says the Inspector, the need of better methods of fastening tires to the wheels.

January 17, 1871, passenger train on Midland line was derailed near Draycott by a broken tire under a passenger carriage. The tire was of iron, fastened on by 4 bolts, tapering from 1⅛ to ¾ in. diameter. It broke into 3 pieces. This was another case of poor fastenings.

November 9, 1871, passenger train on Great Western line was derailed near Windsor by the breaking of a wheel under a passenger carriage. This was a Mansell wheel, 43 in. diameter. This wheel is made with a steel or iron tire and a cast-iron hub, the space between being filled by an annular disk of teak wood, made up of 16 pieces, 3½ in. thick and about 15 in. long. The hub has a circular flange on one side, and a heavy washer slips over the other end, the two being bolted together by 8 bolts, holding the wood blocks at that end. On the outer end the tire is made with a dovetail on each side and two circular iron rings, which fit into the dovetail and project considerably beyond the inside of the tire. These rings are fastened by 16 bolts, one passing through each section of the wood. In this case most of the wood broke from the center, leaving an irregular rim and the tire with no center. Only one of the bolts was broken. The wheel is to be improved in the future by increasing the size of the bolts and putting in a larger hub. The Inspector calls this a very good wheel.

November 8, 1871, passenger train on Midland line was derailed near Kingsbury Wood by a broken tire on a driving-wheel of the locomotive. This tire was of steel, 6 ft. 6 in. diameter, had run 80,110 miles, and had been turned and worn down from 2⅜ in. to 1⅜ in. thick on tread. It broke into two pieces, showing an old flaw at one of the breaks.

November 10, 1871, passenger train on Midland line was derailed at Borrowash by broken tire on a locomotive driving-wheel. This tire was of crucible steel, had run 87,800 miles and had been three times turned up; it was 1⅝ in. thick, having been reduced from an original 2⅜ in. It was shrunk on the wheel-center and secured to it by seven ⅞-in. screws tapped into the tire about 1 in. from the inside. The tire broke into three pieces and was badly distorted in shape. In this and the preceding case, the want of better fastenings for the tire is blamed for most of the damage done.

November 12, 1871, express train on Northeastern Railway was thrown from the track near Learnside by broken tire on a leading wheel of the locomotive. The whole train left the track and two carriages upset, injuring 3 passengers. The broken tire was nearly new; it was of cast-steel, was 54 in. in diameter and 2⅛ in. thick on tread. It had a flange on the outer face bearing against the rim of the wheel-center, and was fastened to the center by four ¾-in. countersunk bolts. It broke into four pieces. It appears that the steel was very hard, so that the workmen in the shop complained that all their tools were dulled in turning it up.

December 1, 1871, passenger train on the Northeastern line was derailed near Killingworth by a broken tire under a van or "horse-box," half of the train leaving the rails and injuring 2 trainmen and 7 passengers. The train ran nearly a mile before it stopped. The tire was of cast-steel rolled out, had been running over four years and had worn down from 2 to 1¾ in. on tread. It broke into 3 pieces, 1½, 3 and 5½ ft. long, respectively. None of the breaks were at bolt-holes, but one of them showed an old flaw extending over the larger part of the sectional area. The tire had a notch or lip projecting ¼ in. over the rim of the wheel in front, and was further fastened by four ¾-in. countersunk bolts. The Inspector says: "This accident adds another testimony to the extreme importance of securing tires to wheels by some method which shall prevent their leaving them in the event of fracture. This is more needful than ever, now that the use of tires of so comparatively uncertain a metal as steel is becoming general."

December 24, 1871, passenger train on Northeastern Railway was derailed near Aycliffe by a broken tire under a passenger car. The tire was of cast-steel, 48 in. diameter and was fastened on by the Beattie method, by which a projecting lip holds the tire to the wheel-center in front, while at the back there are 9 iron clips or keys, held in place by hammering down over them a projecting lip left on the tire for the purpose. The tire broke into 3 pieces, respectively, 34, 44 and 78 in. long. From marks found it was believed that the tire first broke several miles back from the point where it left the wheel altogether. The results on the permanent way were remarkable; 200 chairs, 8 ties and 1 steel rail (82 lbs. section) were broken and had to be replaced.

February 2, 1872, passenger train on Lancashire & Yorkhire road was derailed at Cooper Bridge by a broken tire under the tender. The tire was of iron and riveted ton the wheel by four ⅞ in. rivets. The Inspector here agai takes occasion to recommend improved methods of fastening.

September 17, 1872, passenger train on Great Southern & Western (Ireland) was derailed near Mallow by a broken tire under a passenger carriage. Of this the Inspector says: "The tire that gave away was of cast-steel, made at Leeds in 1870. It made its first journey in August, 1870. It was fixed to the wrought-iron wheel center by five ⅞ in. screw-bolts, and had been shrunk on the wheel, the amount allowed for shrinkage being 0.05 in. in the diameter. The tire showed very little wear. The grain of the metal was good; but when tried in a hydralic press, the steel proved to be brittle. It broke, without yielding, under a pressure of 35 tons applied at the center of a 22 in. bearing. * * It is impossible to prevent tires from breaking. All those hitherto manufactured have done so occasionally. It is, however, possible to prevent their leaving the wheels when they do break."

October 16, 1872, passenger train on the Midland line was derailed near Dronley by broken tire under a passenger carriage, killing 1 passenger and injuring another. The tire was of iron, 39 in. diameter and 1¾ in. thick on tread: it was fastened to the wheel-center by 4 bolts. The tire broke in 4 pieces, 3 of the breaks being at bolt-holes.

December 6, 1872, passenger train on Midland Railway was derailed near Ambergate by broken tire under a passenger car. The tire was iron, fastened by 4 conical rivets, and broke through a rivet hole. Here improved methods of fastening are again recommended.

In the period covered by the part of the summary given above, steel tires appear in considerable number, although iron tires caused a majority of the accidents and were still much more largely in use than steel. With the steel tires the greater number of accidents seem to have been caused by the use of of too hard steel, lacking in the toughness needed in a tire.

As before, the accidents were almost entirely due to the breakage of tires. Only 2 cases of broken wheel-

centers are given; 1 of those was the result of the broken tire, and the other was a wheel with wood center, which failed really because of imperfect construction, the fastenings of the wooden blocks to the hub and tire being insufficient to stand an unusual shock.

It must be remembered that the accidents here noted are only those in which the Inspectors were required to make special investigations and reports, and are not by any means all of those which happened as a result of breakages of wheels and tires.

In 1871, an act was passed by Parliament requiring railroads to make full reports of all accidents occurring on their lines. The imperfect reports for 1871 show a total of 19 broken tires and 4 broken wheels. Of the tires 5 were on locomotive wheels, 2 on tender wheels, 8 on passenger and 4 on freight cars. By these accidents 15 persons were killed and 15 injured.

For 1872 we have not the full figures, but all of the important accidents were investigated and appear in the record.

The later reports, from 1872 on, are very full and many of them are accompanied by illustrations showing methods of construction and proposed improvements.

(*To be continued.*)

English Railroad Accidents in 1886.

THE report of the Board of Trade for the year ending December 31, 1886, gives the number of accidents to trains occurring on the railroads of Great Britain and Ireland during the year, with the number of deaths and injuries to persons caused thereby; also the number of deaths and personal injuries on railroads from other causes than train accidents.

A large number of these accidents were investigated by the inspectors appointed by the Board; in all cases which were not so investigated the causes reported by the companies are given in the return as the causes of the accidents.

The number of train accidents given in the report is as follows:

COLLISIONS:		
Between passenger trains	50	
Between passenger and freight trains	53	
Between freight trains	15	
With projection from train on parallel track	1	
		119
DERAILMENTS:		
Unexplained	73	
Switches	6	
Running into gates at crossings or stations	70	
Cattle or other obstructions	125	
Land slides and wash-outs	41	
Failures of equipment	1,204	
Failure of permanent way	253	
		1,772
OTHER ACCIDENTS:		
Boiler explosion	1	
Broken springs, etc., on locomotives	7	
Fire in trains, etc	12	
Other accidents	5	
		25
Total number of train accidents		1,916

The report does not distinguish between rear and butting collisions. The failures of equipment included 8 broken couplings, 329 broken axles, 866 broken tires and only 1 broken wheel. The failures of permanent way included 247 broken rails, and 6 broken bridges, viaducts and culverts. The most frequent causes of derailments were thus broken tires, broken axles and broken rails.

Of the broken tires 18 were under locomotives, 6 under tenders, 20 under passenger cars, 18 under brake-vans and 804 under wagons or freight cars; 727 of these tires were of iron, 137 of steel, and in 2 cases the material is not stated. It is to be noted that no person was killed or injured in any of the accidents due to broken tires, and the same statement may be made as to the accidents from broken rails.

The number of passengers, employés and others killed and injured in these accidents and otherwise, was as follows:

	Killed.	Injured.
PASSENGERS:		
In train accidents	8	615
Falling from trains, etc., etc	87	727
Total passengers	95	1,342
EMPLOYÉS:		
In train accidents	4	81
In coupling or uncoupling cars	23	301
Other yard and switching accidents	96	867
Falling from trains, etc., etc	37	328
Trackmen, watchmen, etc	265	433
Total employés	425	2,010
OTHER PERSONS:		
At grade crossings	81	25
Trespassers on track	205	91
Suicides	80	
Miscellaneous	52	71
Total, other persons	418	187

It is to be noted that 10 passengers were killed and no less than 496 injured from falling on platforms or roadbed while getting into or out of trains; a large proportion of these injuries were slight, however. Thirteen persons were killed and 17 hurt "from falling out of carriages during the traveling of trains," which seems to be a peculiarly English class of accidents.

As in this country, the greater number of employés were killed or injured in coupling cars and other yard and switching work. A very considerable number were killed and injured on trains in motion or at stations, either by falling from trains, getting on or off trains and in similar ways. Trackmen and station men seem to run about as much risk there as here.

The small number of casualties at grade crossings shows how carefully highway crossings are guarded in Great Britain. It is evident that people will walk on the tracks of a railroad, no matter how carefully it is fenced in, and that so many find such promenades fatal seems to have little effect in deterring them. Human nature is the same on both sides of the ocean, and the danger incurred seems only to increase the temptation.

The total number of casualties resulting from the operation of railroads in Great Britain last year was thus 938 killed and 3,539 injured. Of these casualties only 1¼ per cent. of the killed and 19⅔ per cent. of the injured—15¾ per cent. of the total—were in train accidents proper.

Electricity for Street Railroads.

(From the *Electrician and Electrical Engineer.*)

IT sometimes happens that a person unfamiliar with optical apparatus is best able to appreciate the magnifying power of a telescope by looking at familiar objects through its larger end, and not unfrequently the true condition of other problems may be best apprehended by viewing them inversely. Applying this method to a question of great practical importance just now exciting public interest, let us suppose a manufacturing establishment situated in the heart of a city like New York, where real estate is held at a high value, in which 150 machines, each requiring 10 mechanical horse-power, are driven by the usual equipment of engines and boilers. Now, let us suppose further that the New York State Legislature, in the exercise of the intelligent discretion which that august body invariably applies to the regulation of the internal affairs of the metropolis, should decree that on and after a certain date "It shall not be lawful to operate machinery by steam or any other power than horse-power within the limits of said city," so that it would become necessary for the proprietors of the establishment to purchase a sufficient number of animals to supply 1,500 H. P. continuously, together with the necessary additional real estate in the immediate

vicinity, whereon to erect buildings and furnish stable accommodations for the few thousand head of live stock required, and to add the cost of provender, attendance, replacement, etc. We imagine that the parties concerned would regard themselves as extremely fortunate if the cost of power under the new conditions proved to be less than five or six times as much as before. Yet the situation we have pictured, does not materially exaggerate the existing condition of affairs in respect to city transportation. A single street-railway line in New York has in service about 350 cars and 2,000 horses. Not less than 1,500 H. P. must be constantly employed in the movement of the traffic, yet it would probably be difficult to convince the managers of this or any similarly situated surface-railroad company that the whole line might be operated by a central steam plant and electric motors, at something like one-fourth the cost, for power, of the existing system. The paper of Mr. T. C. Martin, read at the recent annual meeting of the Electrical Engineers, showed conclusively that so far as the use of electric power on small roads with light traffic is concerned, the domain of experiment has already been passed. Electric traction has become a settled fact, and from present indications, nothing can be more certain than that the smaller street-railroad systems of the United States will adopt the new method as rapidly as the required machinery can be constructed and applied. In the case of lines in larger cities with heavier traffic, a similar result may be looked for at no distant day. No valid reason can be adduced why the electric system may not be applied to the more important lines with even greater proportionate economy than has been the case with small roads. It is probable that the only serious obstacle to the change will be the spirit of caution and conservatism naturally inherent in the minds of the managers of corporations having thousands and even millions of dollars invested in horse-power plant, which will lead them to ponder long and carefully before committing themselves to an innovation so radical, and necessarily accompanied with so large an expenditure. Nevertheless, the advantages of the electric system in point of economy and of public convenience must ultimately prove so controlling that it hardly seems probable that even in such cases the inevitable change will be long delayed.

Mr. Martin's summary shows that there are now running in this country 11 electric railways, equipped with 68 motors and motor cars, and that a much larger number are either under contract or in course of construction. The systems of electric distribution from a central station, both by conductors and by accumulators, have proved successful in practice, and it is difficult to imagine any difficulties of operation which cannot be surmounted by one or the other of these methods, or by a combination of the two. Investigations and comparisons of the different methods of electrical propulsion are being made by some of the largest street-railway companies in the country, and such investigations can have, we are confident, but one result.

The table given in Mr. Martin's paper, which is referred to above, we give in a condensed form below:

ELECTRIC RAILROADS IN AMERICA, MAY, 1887.

Place.	Length.	Motors.	Conductors.
Baltimore, Md	2 miles	6	Third-rail and overhead wire.
Los Angeles, Cal	3 "	8	Single and double " "
Port Huron, Mich	4 "	8	Single overhead conductor.
Windsor, Ont	2 "	2	" " "
Detroit, Mich.:			
Highland Park	3½ "	2	Sunken central rail.
Dix Road	1¾ "	4	Double overhead conductor.
Appleton, Wis	4½ "	8	" " wire.
Scranton, Pa	3¼ "	3	Overhead wire.
Denver, Col	3½ "	7	Conduit for series system.
Montgomery, Ala	11 "	18	Overhead conductor.
Kansas City, Mo	..	..	....
Orange, N. J	½ "	1	Overhead conductor.
Boston Mass	..	1	" "

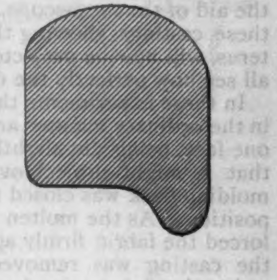
The Boston road is a short line used for moving freight at a sugar refinery; the motor draws a load of 10 tons. The Windsor and Scranton roads take power from the electric-light stations. At Appleton a turbine wheel furnishes power to run the dynamos; at the other places steam engines are used.

New electric railroads are now in course of construction, or under contract, at Pittsburgh (3 roads); Los Angeles; Binghamton, N. Y., 4½ miles, 8 motor cars; Lima, O., 3 miles, 6 cars; San Diego, Cal., 9 miles, four 40 H. P. motor cars; Ansonia, Conn., 3½ miles (water power); New York City (for Fulton Street); St. Joseph, Mo., 20 cars; Mansfield, O.; Ithaca, N. Y.; Harrisburg, Pa.; Woonsocket, R. I.; Richmond, Va., 40 cars, 11 miles of track.

Companies have been formed or steps taken to build and operate electric roads at Flushing, L. I. (2); Lincoln, Neb.; Brookline, Mass. (2): East Cambridge, Mass.; Newton, Mass.; Boston, Mass.; Asbury Park, N. J.; Pelham Park, N. Y.; New Brunswick, N. J.; Plainfield, N. J.; Bayonne, N. J.; Worcester, Mass.: Scranton, Pa.; Carbondale, Pa.; Philadelphia, Pa.; Reading, Pa.; Bangor, Me.; Biddeford, Me.; Westfield, Mass.; Chicopee, Mass.; Muncie, Ind.; Gratiot, Mich.; Tiffin, O.; Cincinnati, O.; Brooklyn, N. Y.; Coney Island, N. Y.; Rockaway, N. Y.; Winston, N. C.; Jacksonville, Fla.; Pensacola, Fla.; Birmingham, Ala.; Selma, Ala.; Atlanta, Ga.; Fort Smith, Ark.; Wichita, Kan.; San Francisco; San Jose, Cal.; Newton, Kansas.

An English Tram-Car Wheel.

THE accompanying illustration shows an English street-car wheel made by Thomas Firth & Sons, Limited, of the Norfolk Works, Sheffield, and shown by that concern at the Manchester Exhibition. The special feature of the wheel is that it is built up of separate parts. The tire is of cast-steel and is bolted to the flat, wrought-iron spokes by 8 bolts passing through lugs cast on the inside of the



tire for this purpose. It will be seen that there is no rim to the wheel, the tire itself forming the rim. The spokes are set in a cast-iron hub, as shown. The total weight of the wheel is 163 lbs.

It is claimed that this makes a light and strong wheel, and that there is the further advantage that when the tire is worn out it can be easily and quickly replaced by a new one.

The larger cut is a perspective view of the wheel; the smaller is a section of the tire.

A Novel Feat in Casting Iron.

[Abstract of remarks made by Mr. A. E. Outerbridge, Jr., before the Franklin Institute, Philadelphia.]

THE art of making charcoal—if, indeed, so crude a process is worthy of being dignified by the name of an art—dates back to a remote antiquity, and has been practiced with but little change for hundreds of years. It is true that some improvements have been recently made, but these relate to the recovery of certain volatile by-products which were formerly lost. Every one is familiar with the appearance and characteristics of ordinary charcoal, yet

I hope to show you this evening that we still have something new to learn about its qualities, and the unexpected practical uses to which it may be applied. We commonly regard charcoal as a brittle, readily combustible substance, but we have before us specimens in which these qualities are conspicuously absent. Take a piece of carbonized cotton sheeting, which may be rolled or folded over without breaking, and, as you see, when placed in a flame of a Bunsen burner, the fibers may be heated white-hot in the air, and when removed from the flame, the material shows no tendency to consume. Here, again, we have a piece of very fine lace, which has been similarly carbonized, and displays the same qualities of ductility and incombustibility.

These carbonized fabrics may be subjected to much more severe tests with impunity, and, when I tell you that they have been exposed to a bath of molten iron without injury, you will readily admit that they possess some qualities not ordinarily associated with charcoal. When removed from the mold in which they were placed after the iron casting had cooled, not a single fiber was consumed, but upon the face of the casting there was found a sharp and accurate reproduction of the design, thus forming a die. This die may be used for a variety of purposes, such as embossing leather, stamping paper, sheet metal, etc., or for producing ornamental surfaces upon such castings. Some of the carbonized fabrics displayed upon the table are almost as delicate as cobwebs, and one would naturally suppose that when a great body of molten metal is poured into a mold in which they are placed, they would be torn to fragments and float to the surface, even though they were unconsumed, yet such is not the case. I have found in practice that the most delicate fabrics may be subjected to this treatment without danger of destruction, and that no special care is needed either in preparing the mold or in pouring the metal. By the aid of the megascope, the enlarged images of some of these castings, showing the delicate tracery of the patterns, will now be projected upon the screen, and you can all see how perfectly the design is reproduced.

In these experiments the mold was made in green sand in the ordinary manner, and the fabric laid smoothly upon one face, being cut slightly larger than the mold, in order that it might project over the edge, so that when the molding flask was closed the fabric was held in its proper position. As the molten metal flowed into the mold it forced the fabric firmly against the sand-wall, and when the casting was removed the carbonized fabric was stripped off from its face without injury. In this way several castings have been made from one carbonized material. These castings are as sharp as electrotypes, whether made of soft fluid iron or of hard, quick-setting metal. The peculiarity is owing to the affinity between molten iron or steel and carbon; the molten metal tends to absorb the carbon as it flows over it, thus causing the fabric to hug the metal closely. It is somewhat analogous to the effect of pouring mercury over zinc. You know that when mercury is poured upon a board it runs into a globular form; it does not wet the board, so to speak, but when poured upon a plate of clean zinc it flows like water and wets every portion of the zinc; or, as we say, it amalgamates with the zinc; so, when molten iron is poured into an ordinary sand mold, which has been faced with this refractorily carbonized fabric, it wets every portion of it, tending to absorb the carbon, and doubtless would do so if it remained fluid long enough, but as the metal cools almost immediately there is no appreciable destruction of the fibers.

Mr. Outerbridge then exhibited some castings which represent a very interesting and novel experiment. In this case, the piece of lace, having open meshes a little larger than a pin's head, instead of being laid upon one face of the mold, was suspended in it in such a way as to divide it into two equal parts. Two gates or runners were provided, leading from the sinking head to the bottom of the mold, one on each side of the lace partition; the molten iron was poured into the sinking head and flowing equally through both runners, filled the mold to a common level. The lace, which was held in position by having its edges imbedded in the walls of the mold, remained intact. When the casting was cold, it was thrown upon the floor of the foundry and separated into two parts, while the lace fell out uninjured, and the pattern was found to be reproduced upon each face of the casting.

The question naturally arises: Why did not the iron run through the holes and join together? The answer may be found in the fact that the thin film of oxide of iron, or skin, as it is popularly called, which always forms on the surface of molten iron, was caught in these fine meshes, and thus prevented the molten metal from joining through the holes. The experiment has been repeated a number of times, and it is found that the meshes must be quite small (not over $\frac{1}{16}$ in.); otherwise the metal will reunite. This observation, perhaps, explains the cause of many obscure flaws found in castings, sometimes causing them to break when subjected to quite moderate strains. We frequently find little cold-shot or metallic globules imbedded in cast-iron or steel, impairing the strength of the metal, and it has long been asked: "What is the cause of this defect?" The pellicles have been carefully analyzed under the supposition that they might be alloys of iron and nickel, or some other refractory metal, but the analysis has failed to substantiate this theory. Is it not probable that, in the process of casting, little drops of molten metal are sometimes splashed out of the stream, which immediately solidify and become coated with a skin of oxide, then falling back into the stream of rapidly cooling metal, they do not remelt, neither do they weld or amalgamate with the mass, owing to this protective coating, thus forming dangerous flaws in the casting?

The process of carbonizing the delicate fabrics, leaves, grasses, etc., is as follows: The objects are placed in a cast-iron box, the bottom of which is covered with a layer of powdered charcoal or other form of carbon, then another layer of carbon-dust is sprinkled over them, and the box is covered with a close-fitting lid. The box is next heated gradually in an oven, to drive off moisture, and the temperature slowly raised until the escape of blue smoke from under the lid ceases; the heat is then increased until the box becomes white hot; it is kept in this glowing condition for at least two hours; it is then removed from the fire, allowed to cool, and the contents are tested in a gas flame, If they have been thoroughly carbonized, they will not glow when removed from the flame, and the fibers may even be heated white hot before consuming.

Of course, the method employed to carbonize the materials is susceptible of variation, but the scientific principles involved are unchangeable; they are:

1. Partial exclusion of air and substitution therefor of a carbon atmosphere.
2. Slow heating to drive off moisture and volatile elements.
3. Intense and prolonged heating of the partly charred objects to eliminate remaining foreign elements, and to change the carbon from the combustible form of ordinary charcoal to a highly refractory condition.

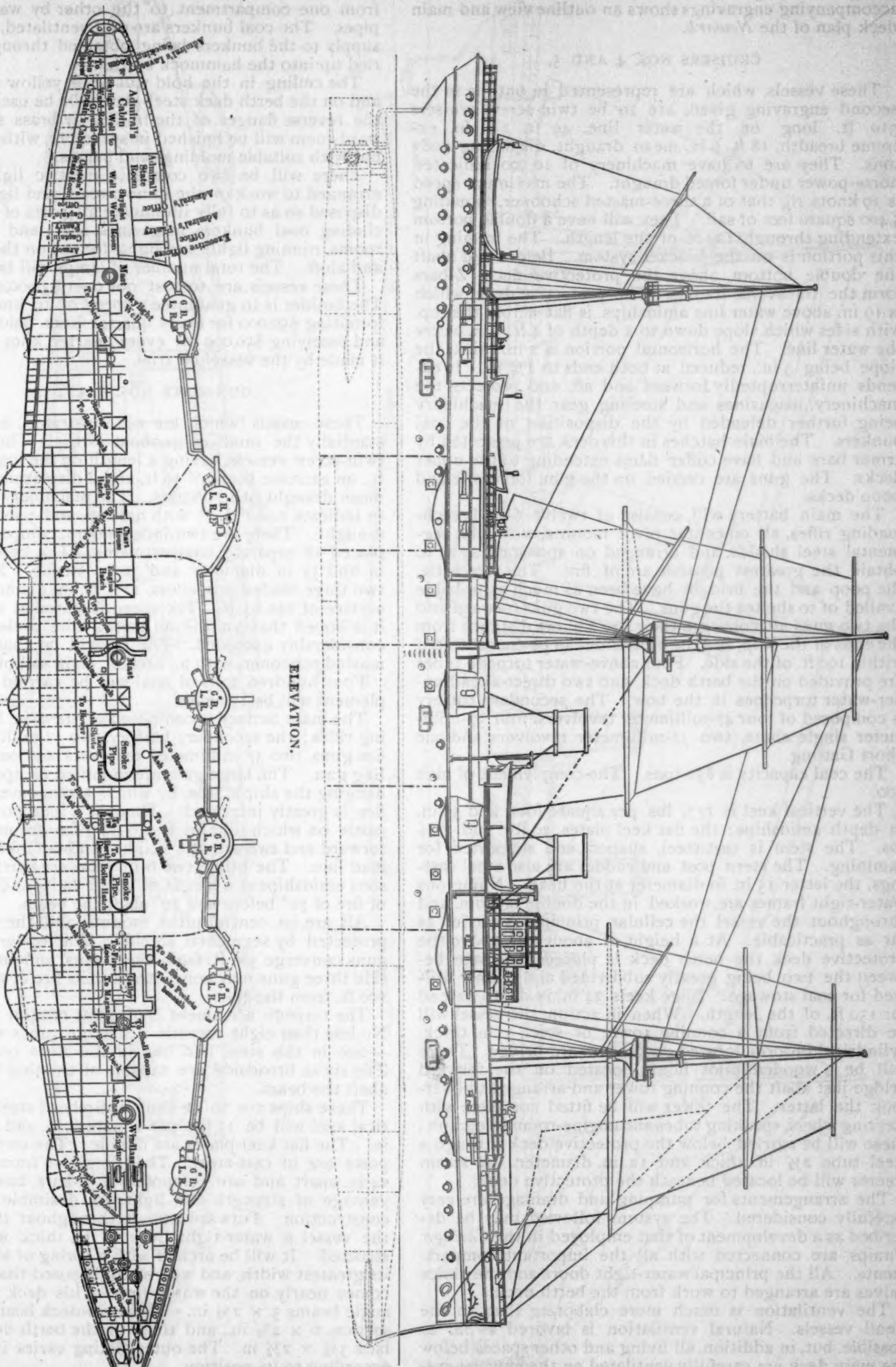
Mr. Outerbridge further states that he now has some castings made from carbonized fine damask napkins, and also from watered silk, showing that designs formed by the weaving of the threads on a flat surface can be reproduced.

THE NEW WARSHIPS.

THE United States Navy Department is now inviting bids for five new vessels—Cruisers Nos. 1, 4 and 5 and Gunboats Nos. 3 and 4—from builders, whose bids are to be presented by August 1 next, and has under consideration plans for two other and heavier vessels, an armored cruiser and an armored battle-ship. For the last two bids have not yet been invited. The engravings given and a part of the descriptions are from the New York *Herald*.

CRUISER NO. 1, THE "NEWARK."

This vessel is to be a partly armored cruiser of about 4,000 tons displacement, and is to cost $1,300,000, exclusive of armament, which will be furnished by the Depart-



ELEVATION.

GUN-DECK PLAN.

CRUISER NO. 1.—THE "NEWARK"—FOR THE UNITED STATES NAVY.

ment. The vessel will be a twin-screw steamer, of steel, much resembling those described below. The first of the accompanying engravings shows an outline view and main deck plan of the *Newark*.

CRUISERS NOS. 4 AND 5.

These vessels, which are represented in outline in the second engraving given, are to be twin-screw cruisers 310 ft. long on the water line, 49 ft. 1¾ in. extreme breadth, 18 ft. 9 in. mean draught, displacing 4,083 tons. They are to have machinery of 10,500 indicated horse-power under forced draught. The maximum speed is 19 knots, rig that of a three-masted schooner, spreading 5,400 square feet of sail. They will have a double bottom extending through 129 ft. of the length. The framing in this portion is on the bracket system. Before and abaft the double bottom, above the protective deck, Z-bars form the transverse frames. The protective deck, which is 19 in. above water line amidships, is flat across the top, with sides which slope down to a depth of 4 ft. 3 in. below the water line. The horizontal portion is 2 in. thick, the slope being 3 in., reduced at both ends to 1½ in. It extends uninterruptedly forward and aft, and protects the machinery, magazines and steering gear, the machinery being further defended by the disposition of the coal bunkers. The main hatches in this deck are protected by armor bars and have coffer dams extending to the upper decks. The guns are carried on the gun, forecastle and poop decks.

The main battery will consist of twelve 6-in. breech-loading rifles, all on center pivot mounts, with 2 in. segmental steel shields, and arranged on sponsons, so as to obtain the greatest possible arc of fire. The forecastle, the poop and the bridges have been as much as possible availed of to shelter the guns. The two guns forward and the two guns aft converge their fire a short distance from the ends of the ship, and the broadside can be concentrated within 100 ft. of the side. Four above-water torpedo tubes are provided on the berth deck, and two direct-ahead under-water torpedoes in the bow. The secondary battery is composed of four 47-millimeter revolvers, four 57-millimeter single shots, two 37-millimeter revolvers and one short Gatling.

The coal capacity is 850 tons. The complement of men 300.

The vertical keel is 17½ lbs. per square foot, and 39 in. in depth amidships; the flat keel plates, 20 lbs. and 17½ lbs. The stem is cast-steel, shaped and supported for ramming. The stern post and rudder are also steel castings, the latter 15 in. in diameter at the head. Numerous water-tight frames are worked in the double bottom, and throughout the vessel the cellular principle is carried as far as practicable. At a height of about 4 ft. above the protective deck the berth deck is placed, the space between the two being greatly subdivided and mainly utilized for coal stowage. Bilge keels 24 in. in depth extend for 150 ft. of the length. When in action, the vessel will be directed from a conning tower of steel, 3 in. thick, cylindrical in form, located on the forward bridge. There will be a wooden pilot house located on the forward bridge just abaft the conning tower and arranged to overlook the latter. The tower will be fitted complete with steering wheel, speaking tubes and engine-room telegraph; these will be carried below the protective deck through a steel tube 2½ in. thick and 12 in. diameter. A steam steerer will be located beneath the protective deck.

The arrangements for pumping and drainage are very carefully considered. The system followed may be described as a development of that employed in the *Chicago*. Pumps are connected with all the important compartments. All the principal water-tight doors and the sluice valves are arranged to work from the berth deck.

The ventilation is much more elaborate than in the small vessels. Natural ventilation is favored as far as possible. but, in addition, all living and other spaces below the main deck are carefully ventilated on the exhaust system, the blowers being entirely distinct from those used for producing the force draught in the fire-room. Large ducts extend forward and aft on the protective deck, receiving smaller ducts from the various rooms and compartments. Where these ducts pass through bulkheads automatic valves are fitted to prevent the flow of water from one compartment to the other by way of the air-pipes. The coal bunkers are well ventilated, the fresh air supply to the bunkers being obtained through pipes carried up into the hammock berthings.

The ceiling in the hold will be of yellow pine battens, and on the berth deck steel-plate will be used, secured to the reverse flanges of the frames by brass screws. The ward room will be finished in sycamore, without pilasters, but with suitable moldings and panels.

There will be two complete electric lighting plants, arranged to work on the same circuit, and lights are to be disposed so as to fully illuminate all parts of the ship, including coal bunkers, magazines, shell and ammunition rooms, running lights and lights for use on the upper deck and aloft. The total number of lamps will be about 400.

These vessels are to cost not over $3,000,000 together. The builder is to guarantee a speed of 19 knots per hour, forfeiting $50,000 for every quarter knot below that point and receiving $50,000 for every quarter knot in excess of it made by the vessel on trial.

GUNBOATS NOS. 3 AND 4.

These vessels (which are not illustrated) are to be substantially the same as gunboat No. 1. They are to be twin-screw vessels, having a length on the load line of 230 ft., an extreme beam of 36 ft. and a displacement at 14 ft., mean draught of 1,700 tons. The machinery is estimated to indicate 2,200 H. P. with natural, and 3,300 with forced draught. There are two independent, compound engines, placed in separate compartments. The cylinders are 29 in. and 52 in. diameter, and 30 in. stroke. There will be two three bladed propellers, 11½ ft. in. diameter; a grate surface of 240 sq. ft. The speed is stated at 16 knots, but it is hoped that on the measured-mile trials this will be considerably exceeded. The rig will be that of a three-masted schooner, with an area of plain sail of 4,409 sq. ft.

Four hundred tons of coal will be carried. The complement will be 150 men.

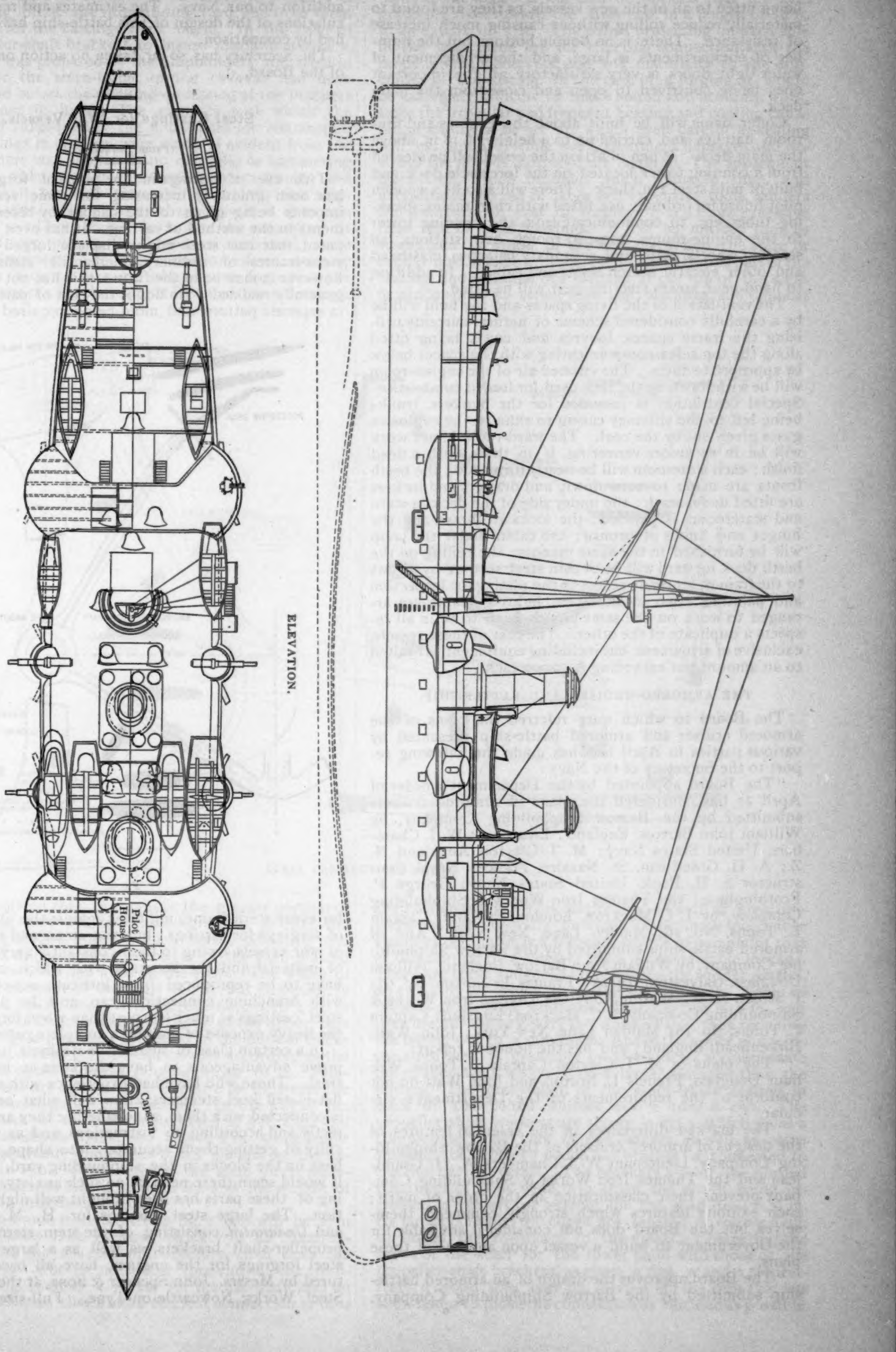
The main battery is composed of six 6-in. breech-loading rifles; the secondary battery, two 57 millimeter rapid-fire guns, two 37 millimeter revolvers and one short Gatling gun. The large guns are mounted on sponsons overhanging the ship's side, by which arrangement the arc of fire is greatly increased. There is a long poop and forecastle on which four of the 6-in. guns are mounted, two forward and two aft, at a height of about 18 ft. above the load line. The other two 6-in. guns are carried on sponsons amidships at a height of about 10 ft., and have an arc of fire of 70° before and 70° abaft the beam.

All are on central-pivot mounts, and the gunners are protected by segmental shields. The forward and after guns converge 300 ft. from the pivots, and on the broadside three guns may concentrate their fire at a distance of 100 ft. from the side.

The torpedo armament is of great relative importance. No less than eight torpedo discharge tubes will be fitted —one in the stem and one in the stern being fixtures. The six in broadside are capable of training forward and abaft the beam.

These ships are to be built entirely of steel. The vertical keel will be 15 lbs. per square foot, and in depth 25 in. The flat keel-plates are double. The stem and stern posts are of cast-steel. The transverse frames are to be 24 in. apart and are composed of Z-bars, having the advantage of strength and lightness, desirable in warship construction. Forward and aft throughout the length of the vessel a water-tight deck ⅜ in. thick will be constructed. It will be arched with a spring of about 3 ft. in its greatest width, and will be so disposed that the crown comes nearly on the water line. This deck will rest on angle beams 5 × 2½ in. The main-deck beams are of T-section, 6 × 4½ in., and those of the berth deck of angle bars 3½ × 2½ in. The outer plating varies in thickness, according to its position.

Protective plating 1 in. thick is worked in the wake of the torpedo ports and machine guns. All water-tight work is to be calked metal to metal, and the interposition of any canvas or felt is prohibited. Bilge keels, projecting.



ELEVATION.

PLAN OF POOP DECK.

CRUISERS NO. 4 AND 5, FOR THE UNITED STATES NAVY.

18 in., will extend for about 100 ft. amidships, and are being fitted to all of the new vessels, as they are found to materially reduce rolling without causing much increase of resistance. There is no double bottom, but the number of compartments is large, and the arrangement of water tight doors is very satisfactory, all the important ones being contrived to open and close from the main deck.

Coffer dams will be built about the engines and fire-room hatches and carried up to a height of 18 in. above the main deck. When in action the vessel will be steered from a conning tower located on the forecastle deck and built of mild steel 2 in. thick. There will also be a wooden pilot house for ordinary use, fitted with chart tables, speaking tubes, etc., to communicate from the conning tower to the engine-rooms, torpedo-rooms and stations, all steering wheels, main and secondary batteries, masthead and other electric search lights and cabins. In addition to hand-gear, steam steering-gear will be fitted.

The ventilation of the living spaces and the hold will be by a carefully considered scheme of natural currents utilizing the frame spaces, louvres and cowls being fitted along the top sides, communicating with the spaces below by appropriate ducts. The vitiated air of the engine-room will be withdrawn by the fans used for forced combustion. Special ventilation is provided for the bunkers, trunks being led to the chimney casing to exhaust the explosive gases given out by the coal. The ward-room joiner work will be in sycamore veneering, ¼ in. thick, with a dead finish; each stateroom will be neatly furnished; the berth fronts are made to turn down, and drawers and lockers are fitted underneath; the under side of the deck in ward and staterooms is paneled; the locks are brass, and the hinges and knobs of bronze; the cabin under the poop will be furnished in the same manner; the ceiling on the berth deck forward will be of thin steel, secured by screws to the frames, for ready access to the plating for inspection and painting; two incandescent lighting plants are arranged to work on the same circuit, each to be in all respects a duplicate of the other. The cost of these vessels, exclusive of armament, but including equipment, is limited to an amount not exceeding $550,000 each.

THE ARMORED CRUISER AND BATTLE-SHIP.

The Board to which were referred the plans of the armored cruiser and armored battle-ship presented by various parties in April last, has made the following report to the Secretary of the Navy:

"The Board appointed by the Department's order of April 22 has considered the plans of armored cruisers submitted by the Barrow Shipbuilding Company, by William John Barrow, England; Lieutenant W. I. Chambers, United States Navy; M. T. Clayton, Auckland, N. Z.; A. H. Grandjean, St. Nazaire, France; Naval Constructor S. H. Pook, United States Navy; George P. Frothingham; the Thames Iron Works & Shipbuilding Company, by I. C. Mackron, London, England; Captain L. Tonns, No. 164 Maiden Lane, New York. And of armored battle-ships submitted by the Barrow Shipbuilding Company, by William John Barrow, England; William Douglass, Galveston, Texas; Francis L. Norton, No. 633 F Street, N. W., Washington; the Thames Iron Works & Shipbuilding Company, I. C. Mackron, England; Captain L. Tonns, No. 164 Maiden Lane, New York; John Watt, Birkenhead, England; and has the honor to report:

"The plans of M. T. Clayton, Captain L. Tonns, William Douglass, Francis L. Norton and John Watt do not conform to the requirements of the Department's circular.

"The marked differences in the essential features of the designs of armored cruisers of the Barrow Shipbuilding Company, Lieutenant W. I. Chambers, A. H. Grandjean and the Thames Iron Works & Shipbuilding Company prevent their classification in the order of merit; each exhibits features which strongly commend themselves, but the Board does not consider it advisable for the Government to build a vessel upon any one of these plans.

"The Board approves the design of an armored battle-ship submitted by the Barrow Shipbuilding Company, and is of the opinion that such a ship would be a valuable addition to our Navy. The estimates and results of calculations of the design of this battle-ship have been verified by comparison."

The Secretary has, so far, taken no action on this report of the Board.

Steel Castings for War Vessels.

(From *Industries*.)

THE use of castings in the place of forged material has been gradually increasing for some years, a great impetus being given to the change by recent improvements in the method of casting. It has even been anticipated that cast-steel might displace forged iron in the stern-frames of ordinary mercantile steamers; but, however it may be in the future, this has not as yet been generally realized. No doubt the cost of pattern-making (a separate pattern and mold being required in practice

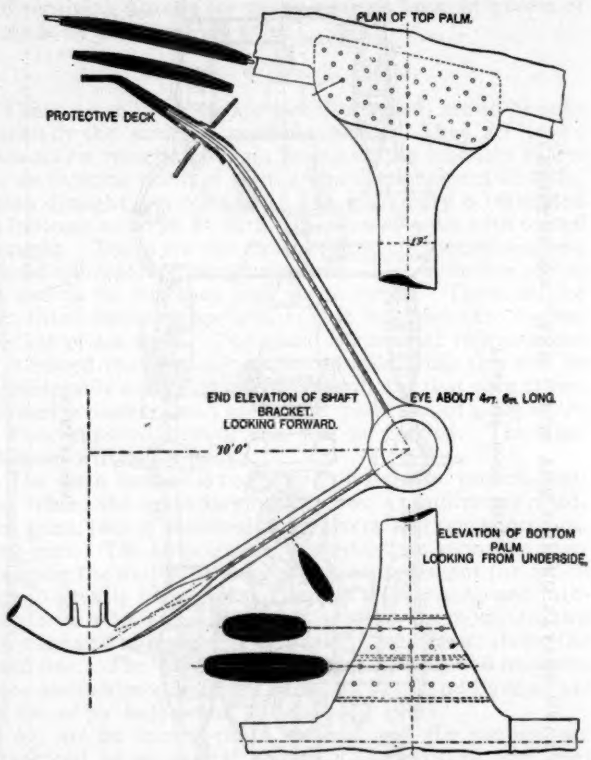


FIG. 3.

for every stern-frame) militates against the abandonment of forgings for castings; but the stems and stern-frames of war vessels, owing to their constantly varying sections of material, and the accuracy with which curved lines have to be reproduced from intricate set-offs, together with branching connections, can now be produced as steel castings at much less cost than when forged, despite the heavy expense of making a complete pattern.

In a certain class of mercantile steamers, it will usually prove advantageous to have the stem at least of cast-steel. Those who have had experience with the stems of flat-plated keel steamers, know well what anxiety there is connected with them, as to whether they are made correctly and according to instructions, and as to the difficulty of getting them accurately into shape, when being bent on the blocks in the shipbuilding yard. In future, it would seem there need be no such anxiety, as the casting of these parts has been brought well nigh to perfection. The large steel castings for H. M. S. *Orlando* and *Undaunted*, consisting of the stem, stern-frame and propeller-shaft brackets, as well as a large number of steel forgings for the engines, have all been manufactured by Messrs. John Spencer & Sons, at their Newburn Steel Works, Newcastle-on-Tyne. Full-sized drawings

on thin boards, with sections as shown, were prepared in the molding loft at the shipbuilding yard, and from them the molds for the castings were made. In the case of the propeller-shaft brackets, to insure absolute accuracy, a template was prepared by the shipbuilders and tried in place, after the stern-frame of the *Orlando* had been erected, and before the molding or casting of the brackets had been put in hand. The accuracy with which the molds, and subsequently the allowances for contraction of the castings in cooling, were made, is evident from the fact that there was practically no chipping or hammering necessary when the finished stem, stern-frame and propeller-shaft brackets were delivered into the shipbuilder's hands. The stem of these vessels is shown in fig. 1, and, as will be readily seen, is of the ram type. It consists of two pieces, the lower, of cast-steel, alone being represented. The upper portion, of an ordinary bar section with the fore end swaged, was forged at the works of Palmer's Shipbuilding & Iron Company, Limited, made to the keel. It will also be noticed that the keel gradually rises toward the after end, in a length of 18 ft. to an extent of 2 ft. The palms projecting on each side of the keel piece are for effecting connection with the propeller-shaft brackets, and add materially to the difficulties of the casting. In the case of a forging, it would be extremely difficult to make sound and accurate work, since the irregular and frequent heating and cooling cause initial strains to be set up, which even careful annealing will not remove, while such treatment damages and destroys the fibrous nature of the material. The subsequent machining, which occupies much valuable time, and necessitates the use of large and expensive tools, renders the comparative cost of forgings much more excessive than that of steel castings. It will be noticed that, to strengthen the union of the keel-piece and the stern or rudder-post, a knee or fillet, 1½ in. thick, forms part of the casting, and a similar one is fitted at the top of the stern or rudder-post to strengthen the platform, and connect

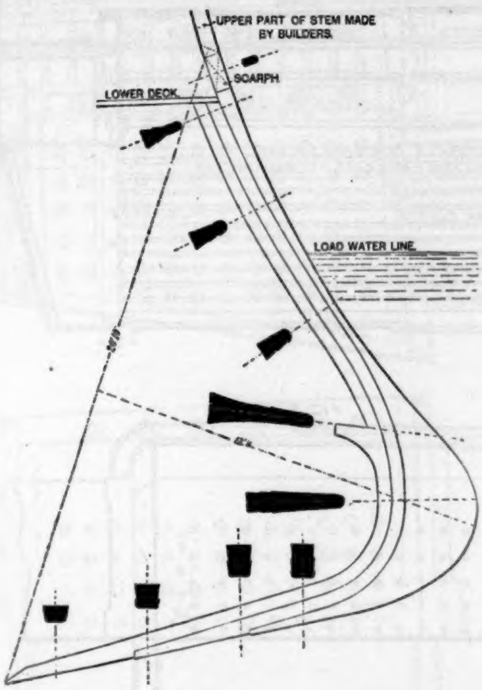


FIG. 1.

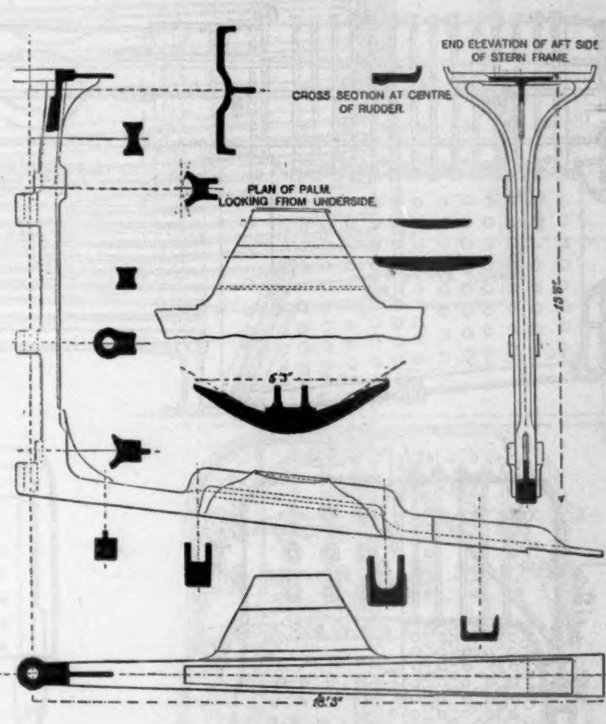


FIG. 2.

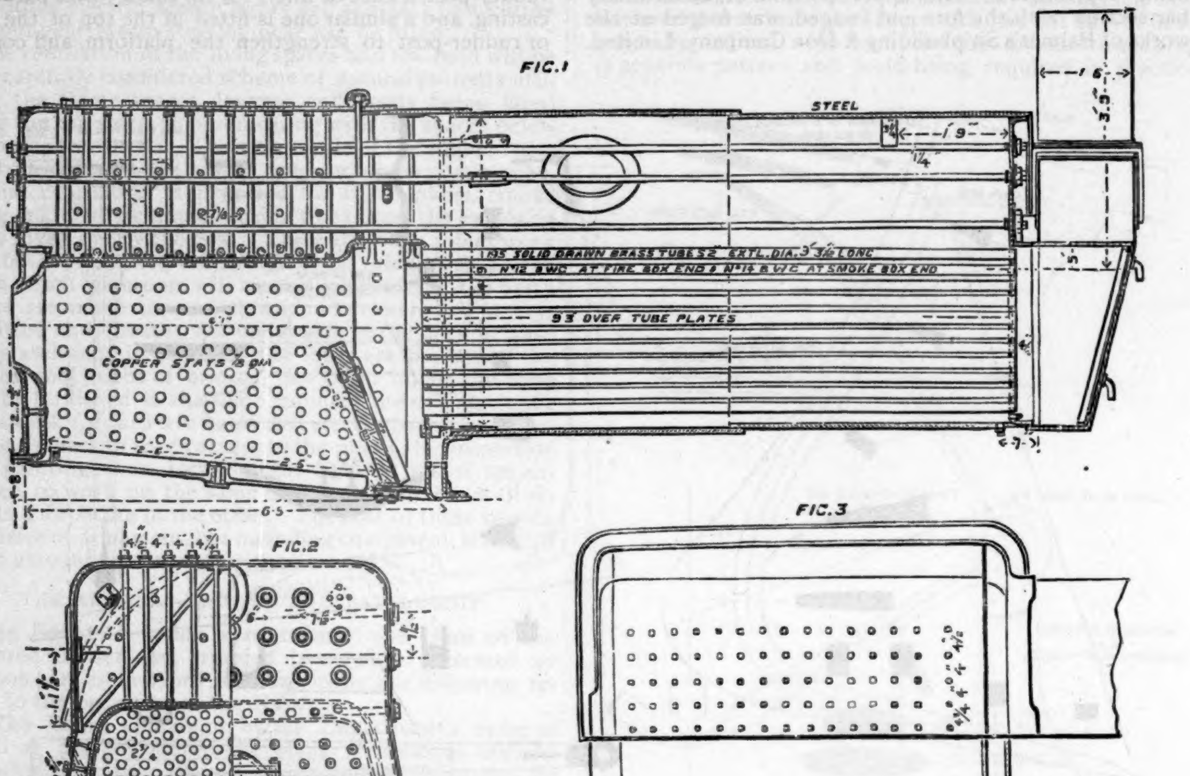
STEEL CASTINGS FOR SHIPS.

It will be noticed that, throughout the greater portion of this casting, there are two molding edges, so that the shell-plating might make a flush finish, obviating the necessity of thinning away the edges of the shell-plating where they overlap and abut on the stem. The width of the stem at the root of the scarf is 6 in., but immediately beneath the lower deck it is increased to 1 ft. 4 in. in width. The thickness, which is 2½ in. at the upper part of the casting, is gradually increased to the normal thickness of 5 in., and to greater thicknesses according as the form of the vessel requires, ranging up to 10 in. Sufficient sections are shown in the figure to illustrate the different scantlings of this casting. In the way of the ram, the width of the stem is increased to 3 ft., 2 in., and at the breast-hook connection to 3 ft. 4 in., while below the ram it gradually diminishes to 4½ in., and at the extreme end to 1 in. The length of the stem piece, measured on a diagonal line, is 20 ft. 10 in., and the weight of the casting a little over 4¾ tons.

The stern-frame is illustrated in fig. 2, and will be seen at once to show even greater intricacy in its construction, despite the absence of curvature, than does the stem-casting. For 30 in. at the fore end of the stern-frame casting, there is a recess for the flat-plate keel on the under side, so that a more efficient connection is thus the rudder-trunk. This platform is a detail of great importance, not generally provided in ordinary mercantile steamers, so that it is a frequent source of complaint that at this portion of a steamer there is considerable leakage. There are three gudgeons for receiving the rudder pintles, on two only of which does the rudder bear. Each of these is 12 in. deep, while the remaining one is 8 in., and they are all cast to nearly the finished size, thus reducing the boring out to a minimum. Above the upper gudgeon, the stern-post is gradually set forward, to accommodate the rudder-head, which is of a larger diameter than the pintles. The total weight of the stern-frame casting, in each of the belted cruisers, was 8 tons 6 cwt. The propeller-shaft brackets are shown in fig. 3, which gives a complete sectional view of one bracket, as well as plans showing the palms by which the bracket is connected to the hull of the vessel. The brackets are of the normal scantlings of 21 in. wide, 7 in. thick, the width being increased at the eye, or bearing for the shaft, to 4 ft. 6 in. As far as possible, the edges are tapered or rounded off, to lessen the resistance of the vessel. Comparing the views of the scarf for the lower palm with those of the propeller-shaft brackets, as given in figs. 2 and 3 respectively, a good idea may be formed of the care that has been taken to make the connection as efficient as possible.

This is a matter of no small importance, seeing that through each propeller shaft from 4,000 H. P. to 5,000 H. P. will be transmitted. Four rows of rivets, 1⅜ in. diameter, spaced about 7½ in. apart, complete the attachment, as shown in the elevation of the bottom palm, which is increased in width, gradually, to 4 ft. 10 in. The upper palm passes into the hull, and abuts on the terminating portion of the protective deck, as shown. This palm is 5 ft. 10 in. in length or width, and is supplied with relatively greater rivet connection, in this case 1¼-in. rivets being used, spaced about 6½ in. apart. Two rows pass through plates, projecting for the purpose beyond the hull of the vessel, one row through double angle irons and plates inside the shell-plating, and two other rows further in-board; the whole forming a very strong attachment, which it is anticipated will quite suffice for the enormous strains to be developed when the vessel is under full steam. Each of these brackets exceeds 8 tons in weight. By the courtesy of Messrs. Spencer & Sons, we are enabled to give a summary of the tests which were undertaken in connection with the steel employed for these castings. Each of the castings was drop-tested, by lifting it up with a steam traveling crane to a considerable height. It was then allowed to fall upon a macadamized road surface. Each of them was also lifted up, having one end resting on the road, and the other end forming an angle of 60 deg. with the surface of the road, and dropped from this position, Having been subjected to these severe tests, each casting was suspended and hammered with heavy hammers to try its soundness, and in every instance with the most satisfactory results.

A stern-post for one of the new gunboats was recently made by the Standard Steel Casting Company, the first casting of this kind, we believe, ever made in the United States.



THE YARROW TORPEDO-BOAT BOILER.

Casualties in Torpedo Boats.

(From the London *Engineering*.)

We told our readers in our last impression the story of the explosion of a boiler on board a torpedo boat. At the time we went to press our information was scant. Official, and, we may add prudent, reticence interfered to prevent anything like a detailed statement of the truth. Since we wrote, the facts have become public; and they are far more serious and important than appeared at first sight. The Admiralty wisely determined to test a flotilla of torpedo boats purchased for the Navy at various times. The test was different from anything made before. Hitherto boats have been tried as weapons of attack and defense. Their sea-going qualities up to a certain point have been made the subject of experiment; but nothing was really known concerning their powers of endurance when steaming at full speed in charge of naval engineers. Now it is obvious that in case of actual war our torpedo boats might be called on to steam long distances in order to repel a threatened attack, and it is also clear that under such circumstances they would be called upon to go from place to place as fast as they could go. It was decided for these reasons that the boats of the flotilla should race over a distance of about 100 miles. * * *

Opinions differ as to the value of torpedo boats, but it is certain that no maritime power could be without them; and the fact that, out of 24 British boats, no fewer than 8 were rendered *hors du combat* as soon as they were worked under conditions which might—and probably would—obtain any or every day if we were at war, is extremely serious. The failures we have recorded possess a national importance. It is a noteworthy fact that all the boats which broke down were by the same firm. There were 4 boats by Messrs. Yarrow & Co., 3 boats by White,

of Cowes, the remaining 17 were by Thornycroft. If we refuse to class the failure of a propeller as a breakdown because the boat was still able to proceed, though at reduced speed, we find that the casualties to the boats of the Chiswick firm came to over 41 per cent. If out of 100 torpedo boats 41 are to become unserviceable within an hour after they proceed to sea, confidence in the utility of such craft will be weakened. It may be urged—and has already been urged to some purpose—that the failures were due to the incompetence of the men in charge. If this were wholly true it would imply a very serious indictment of the Admiralty; we refuse, however, to believe it. While we admit that had more care been exercised in the stokeholes it is possible that no breakdown would have occurred, we hold that any system of design or construction which renders boilers and engines dependent for their safe working on exceptional skill and vigilance, must be defective. Whatever the probable shortcomings of the crews in charge could possibly have been, we think the main cause of the failures must be sought and found in the machinery of the boats, and even in the boats themselves, and we fancy, before we have done, that our readers will be of the same opinion. As we know nothing yet of the nature of the failures which took place in the engine or boiler rooms of Nos. 27, 41, 50, 42 and 55, we can say little about them. No. 27 had hot bearings; but they must have been very hot indeed to stop the boat. The bearings in a torpedo-boat engine are so comparatively small and light, and the appliances for cooling so perfect, that, as is known from experience, a very hot bearing can be cooled in a very few minutes; and in a long race, such as this under consideration, 5 minutes' delay at the outset could not destroy the chances of a boat. Putting this on one side, however, we may confine ourselves to two casualties, namely, the failure of the boilers in No. 47 and No. 57. In both cases the crowns of the fire-boxes came down. In No. 47 the failure was sudden and complete; and, as we know, lives were lost. In the case of No. 57 the failure of the crown plate was not so sudden and complete, and no lives were lost; although the risk incurred was awful. Why did the furnace crowns come down? The first reply that will suggest itself to an engineer is that they came down because the boilers were short of water. On this point, however, there is a great deal to be said; and in order that our readers may comprehend the whole matter, we give here two sets of drawings—figs. 1, 2 and 3—showing the system of construction adopted by Messrs. Yarrow & Co.; and figs. 5, 6 and 7, that used by Messrs. Thornycroft & Co.

At first sight there does not seem to be much difference between them, but there is a difference—a most essential difference in detail. It will be seen that in neither boiler are bridge-stays used. The tops of the inside and outside fire-boxes are secured to each other by stays. It will also be seen by fig. 8 that the stays used by Messrs. Yarrow have large heads jumped up out of the solid and forged to shape; that under these heads is a screw thread; that the opposite ends or points are also screwed. The stays are turned down between the threads, so that the threads stand up. These bolts are then screwed hard into place from the inside, and large square nuts are then screwed on the ends projecting on top of the fire-box shell. In locomotive work the crown-stay bolts always have heads or nuts inside the fire-box on the crown stays.

Turning now to Mr. Thornycroft's boiler, it will be seen by fig. 4 that he dispenses with nuts and heads. His stays are screwed, just as Mr. Yarrow's are, but there the resemblance ceases. The ends of the stays are riveted over—the crown-stays thus resembling the side-stays. This we regard as an essentially weak system of construction, and to it we believe the failure of the boilers in Nos. 47 and 57 was partly due. The system of riveting

FIG. 5

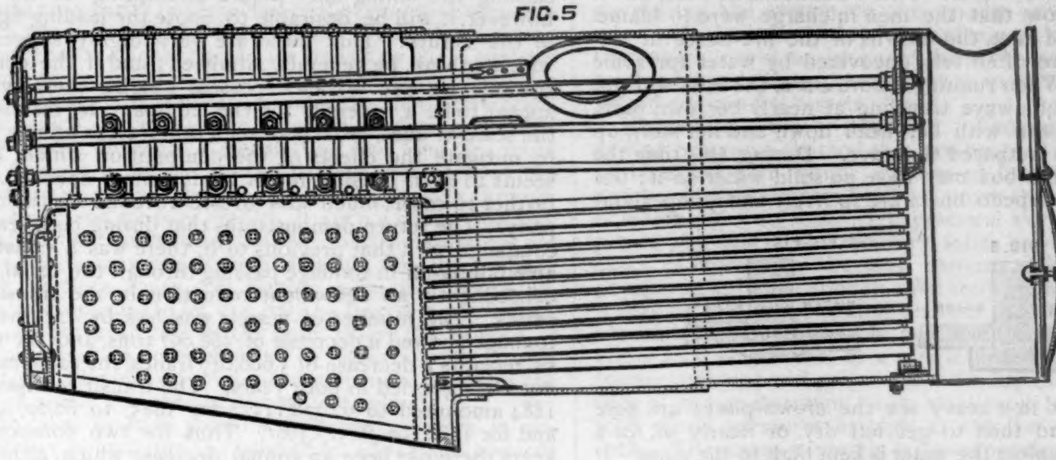


FIG. 7

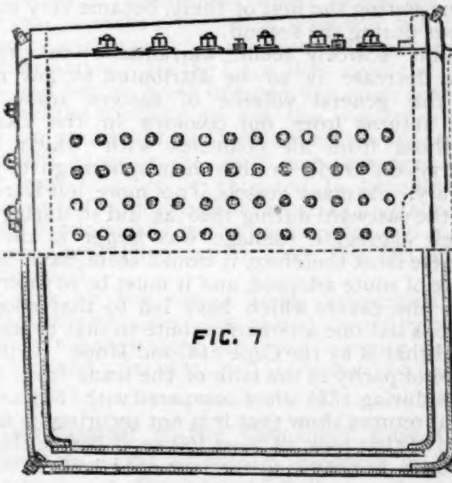
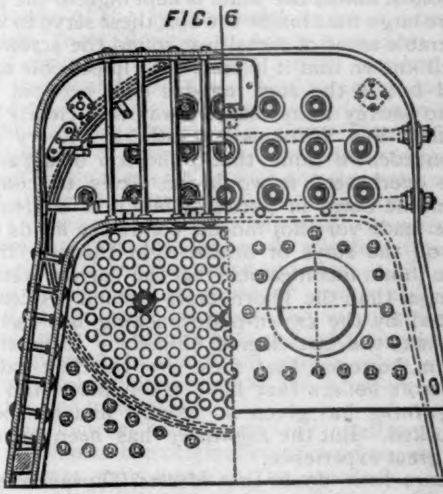


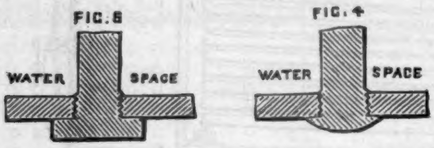
FIG. 6



THE THORNYCROFT TORPEDO-BOAT BOILER.

over cold answers well enough in a side-stay which is not more than 6 in. or 7 in. long over all; but the crown-stays are over 2 ft. long, and riveting up cold has a very great tendency to do more harm to the screw thread in the $\frac{7}{16}$-in. crown plate than anything else, for it is next to impossible properly to hold up a bar 2 ft. long to the riveting hammer. It may be urged that a screwed and riveted stay is just as strong as a screwed stay with head and nut. This we deny. That it may be quite strong enough under ordinary circumstances is one thing; that it is strong enough for torpedo-boat boilers does not at all follow as a legitimate consequence. It will not do to assume that, because such a system of construction may give good results in a locomotive boiler, it must do so in a torpedo-boat boiler. It has been urged that the crown-plates came down in No. 47 and No. 57 because the plates were overheated from shortness of water. This we concede at once, but it does not follow that the men in charge were to blame. As a matter of fact, the crowns of the fire-boxes in torpedo-boats are often left uncovered by water for some little time. When running before a sea, the boat will get on the back of a wave traveling at nearly her own pace, and she will run with her head down and her stern up until she has outpaced the wave. During this time the crown of the fire-box may have no solid water on it; but besides this, torpedo boats are so lively and jump about

FIG. 3 FIG. 4



so much that in a heavy sea the crown-plates are sure every now and then to get left dry, or nearly so, for a few seconds, unless the water is kept high in the glass. If there are large nuts inside the box, these serve to keep cool considerable areas of metal just round the screw-threads. It is well known that it is practically impossible to make a nut red hot if the stay remains cool, because the stay serves to convey away heat in a way very clearly set forth by Peclet, Wye Williams and others. Every engineer will concede, we think, that if the top of a Yarrow box became overheated, it would be likely to come down between the stays in pockets; but it is evident that it must be made very hot indeed before the heads could be forced off the stays or drawn right through the plate. It is, we think, incontestable that the Yarrow system must be stronger than the Thornycroft system. A leak might be started by the crown-plate cracking, but its total disruption is to the last degree unlikely. It must not be forgotten, however, that these are the first failures of Thornycroft boilers that have taken place, and that the old *Lightning* has given no trouble and has been very hard worked. But the *Lightning* has been managed by men of great experience.

We have little doubt that Messrs. Thornycroft's other failures have been due to the desire to make the machinery of their boats as light as possible. It is a matter of interest to know that the Yarrow boats of the same dimensions weigh nearly seven tons more than the Thornycroft boats. Of this 3½ tons go to the hull and 3½ tons to the engines and boiler. For example, it will be seen by fig. 1 that Messrs. Yarrow & Co. raise the forward end of the internal fire-box. They thus get room for more tubes without raising the crown plate as a whole. The small portion actually raised being near the mid-length of the boiler, where the water level is not much affected by pitching, it is always covered. But the result of adopting this system of construction is that the boiler holds an extra half-ton of water. Messrs. Thornycroft's engines are speeded higher than Messrs. Yarrow's, the pitch of the screws being finer; and this we hold to be objectionable. Nothing can exceed the skill with which the Thornycroft engines have been designed and made; but facts are too strong for them and the advocates of high-speed engines. Those who hold that we may yet have 40-knot passenger steamers may draw an instructive lesson from the torpedo-boat race of May, 1887. The consolatory feature of the whole affair is that the boats of Messrs. Yarrow and Mr. White did their work without a hitch or difficulty of any kind, and it is not to be supposed that their engine-room staffs were better than those of the Thornycroft boats.

The Traffic of the Suez Canal.

(From the London *Engineering*.)

AN official return just issued by the Suez Canal Company shows such a diminution of traffic to and from the East by this route, that it will be interesting to consider the conditions which may be deemed to be operative in causing the falling off. Before attempting to do this, however, it will be desirable to quote the leading figures of the return. That these are very highly suggestive will, we think, be generally admitted; and if the considerations we can advance possess weight, there would appear to be a necessity for the company to reconsider the scale of dues, or to take such other steps as may tend to mitigate the effects of the competition which, as it seems to us, is causing and is likely, unless checked, still further to cause, much loss to the revenue of the company. The return demonstrates that during last year, as compared with that previous to it, there was a considerable falling-off in tonnage passing through the canal, and consequently an equivalent reduction in the transit receipts. The number of vessels was less by 524, the net tonnage showed a decrease of 568,097 tons, and the transit receipts a decrease of 5,680,049 francs, the same rate of dues being levied in both years. The transit receipts for 1884 amounted to 62,378,115*f.*; for 1885, to 62,207,439*f.*; and for 1886, to 56,527,390*f.* Thus for two consecutive years there has been an annual decrease which, although but trifling during the first of them, became very marked and serious during the second.

It would scarcely seem warrantable to presume that this decrease is to be attributed to any reduction in the general volume of eastern trade. Indeed the returns from our colonies in the East, as well as those from all countries with which Europeans carry on trade in that hemisphere, go to prove the contrary. As many vessels, if not more, left European ports for the eastward during 1886 as did so during 1884, while their aggregate tonnage was larger in the later year. There must therefore, it would seem, have been a divergence of route adopted, and it must be of interest to determine the causes which have led to that adoption. Now there is but one alternative route to that by the Suez Canal, and that is by the Cape of Good Hope. If there is any degree of parity in the bulk of the trade from European ports during 1886 when compared with 1884, and the Suez Canal returns show that it is not securing its former proportion of that bulk, it must follow of course that the long sea route is obtaining the increased balance of the traffic. It is a fact worth noting that the decreased figures which represent the Suez Canal traffic occur simultaneously with, and bear some relative proportion to, the advance made with the triple-compound engine. It was only during 1884 that this system received any extended trial, and during 1885 it had very considerable extension. But during last year, the results of the two previous years having fully demonstrated the economy of triple expansion, every steamship owner who was in a position to do so hastened to adopt it, a very large number of existing vessels having their engines modified, while but comparatively few new steamers were launched the engines of which were not on the new principle.

The very important saving of coal effected by this change has tended greatly, we should say, towards increasing the flow of our eastern trade *via* the Cape of Good Hope. Steamers bound for Australia and the eastern ports generally have, with but few exceptions, hitherto been obliged to call in at the Cape to fill up with coal. A call of that kind is at no time without expense, and it of course entails delay, which further adds to the cost of the voyage. Then, again, the necessity

prevents the ships from following the quickest course, which lies some 300 to 400 miles south of the Cape. These delays and cost are avoided in the case of the steamers which are capable of steaming their entire journey without putting in for coal; and it may be said, we think, that this advantage has perhaps been secured to the majority of our steamships by the introduction of the triple-expansion engine. There seems to be a parallelism of occurrence between the adoption of engines of that type and the reduction in the traffic of the Suez Canal, and the fact cannot but be noteworthy when considering the causes operating towards that reduction. Now, proceeding further upon this basis, we find, if our argument has any material degree of soundness, that the cost of working steamships by the Cape route has been reduced by the several savings above mentioned, while that route is quite on a parity in respect of coal-saving with steamers which adopt that by the Suez Canal. From this we may deduce that the fees charged for transit by the Canal are so high as to now outbalance the advantages it offers of a lesser mileage. It is cheaper, under the modified conditions which have become established during the last three years, to send a steamer by the long sea route than to send it by the shorter passage, weighted as the latter is with the heavy fees charged for passage through the canal; and we may predict, if such a conclusion may be said to be established, that we shall, unless steps are taken which may check such a result, see the tonnage using the Suez route still further annually decreasing. This, as it appears to us, can only be stayed by the reduction of the transit fees to the point where the balance of economy may be re-established in favor of the shorter passage. The fees on a 3,000-ton ship now represent the cost of nearly that weight of coal in England.

The cause we have stated must prove operative in another way in inclining the balance of advantage towards the Cape route. Everything which brings the duration of the two journeys more nearly level will induce a preference by passengers for the latter method of reaching their destination. By the Cape they avoid the great heat of the Red Sea, so much dreaded by a large proportion of them, and the curiosity to see the numerous places at which our mail steamers stop on their voyages palls after one or two experiences. Both our passenger and cargo traffic may therefore be expected to become more and more diverted from the Canal route as high speed can be attained economically by the ocean route, and it behooves the Suez Canal Directors to take the fact into serious consideration.

We note by the return under reference, that Great Britain, during the year just passed, owned 77 per cent. of the whole tonnage using the canal. France had 8.25 per cent., Holland 4 per cent., and Germany 3.69 per cent.

The Development of the Compound Engine and the Probable Limit of Steam Pressure in Marine Engines and Boilers.

[Paper read before the American Society of Mechanical Engineers, by Charles E. Emery, New York.]

FIFTY years ago, when steam navigation was in its infancy, the steam pressure employed in marine engines was as low as 5 to 10 lbs., but as boiler construction improved a rapid increase took place to 20 and 25 lbs., until finally a sort of standstill, at a maximum of about 40 lbs., was established for a series of years. This pressure was considered so high that compound engines were constructed in which to use it. Some notable examples running on the west coast of South America were familiar to marine engineers some 20 years ago, and curiously enough the reports which came from those engines corresponded closely with the reports from modern engines of certainly better economy, in that it was claimed that the power was obtained with the consumption of 1¾ lbs. of coal per indicated horse-power per hour. Higher pressures were in vogue on inland waters almost from the commencement of steam navigation on the same, but were introduced much more slowly on sea-going steamers. As improvements in the mechanical arts progressed, it was found that steam boilers could be safely constructed to carry higher pressures, and steam machinery for using steam at a pressure of 60 lbs. and more was made from time to time. Engines of the compound type were made at an early date but did not at first find much favor, and it was not until about the year 1870 that this engine was what may be called reintroduced and established as the marine engine of the future. The initial successes of this period were doubtless made by various constructors in Great Britain, the firm of Elder & Co. being probably in the lead. Mr. Thomas W. Lay, at about the same time, established a certain form of engine of this class on the Great Lakes. The writer also, through opportunities given as Consulting Engineer of the U. S. Coast Survey and Revenue Marine, took an active part in developing the system on the smaller government vessels—and the information thus obtained, together with that which could be procured from abroad, was utilized by the United States naval officers in designs for compound engines for vessels of war.

Meanwhile, the "doubting Thomases" among marine engineers claimed that just as good results could be obtained with single engines of long stroke, and a number of vessels were built to prove this theory, many of which did very well. The practical work of the compound engines in this country soon, however, had the effect of converting the most earnest advocates of expansion in a single cylinder. Without mentioning names it may be said that one after another the older engineers succumbed to the inevitable, and now the writer does not know of a single one, or a single firm, that adheres to former opinions and prejudices. To-day there are numbers of ocean steamers, both small and large, running with steam pressures as high as 160 lbs. to the square inch. The steam is used in triple-expansion engines, and the advocates of the system claim as great economy in the change from double to triple expansion as was originally claimed in that from simple engines to the ordinary compound engines. Undoubtedly overstatements are made as great as those formerly made in relation to the ordinary compound engine. The results with the latter should of course have been compared only with those from engines operating with the same steam pressure and under the best conditions for economy at that pressure; whereas they were frequently compared with those from low-pressure engines of obsolete type. The performance of the triple-compound engines are not only not being compared with those of compound engines operating at the same pressure, but comparisons have been made with the results obtained with engines which have been allowed to run down, and in cases where the boilers have deteriorated so that the pressure originally intended is not maintained.

With the view of settling various questions of this kind in relation to the original compound engine a series of experiments were made in the years 1874 and 1875, under the general direction of Chief Engineer Charles H. Loring, U. S. Navy, representing the Navy Department, and the writer, representing the Treasury Department, with the machinery of various revenue steamers, designed by the writer, one having a compound engine, another a high-pressure condensing engine, another a similar engine with a jacket, and another with a low-pressure engine.

These experiments showed that at the pressure employed, viz.: 70 lbs., the gain due to compounding was only 12 to 15 per cent. as compared with using the steam with an equal degree of expansion in a single cylinder. Official reports of these experiments were made to the Navy and Treasury departments and the results discussed by the writer in several journals. Abstracts of the reports were also made by various periodicals and embodied in the current literature on the subject. In the discussion, the writer stated that the average economy of compound engines was doubtless nearer 25 per cent. than 12 to 15, on account of mechanical difficulties incident to keeping in order single engines working at a high degree of expansion and the liability of the engineer to reduce the steam pressure and follow a little further in the stroke to relieve the strains on his joints and all the working parts.

of the engine and save himself work. The same difficulty was experienced with the first compound engines, and is supposed to be one reason why the Elders, in their original engines, set the main valves to cut-off with full link at about one-half the stroke on the high-pressure cylinder, so that the engineer could only control the cut-off with the independent gear within that limit. In the above experiments a horse-power was obtained in the compound engine of the U. S. Revenue steamer *Rush* for 18.38 lbs. of feed-water per hour, the steam pressure being nearly 70 lbs. Now, if the steam supplied to the engine in this case had been generated at about 160 lbs. pressure, and used to operate another piston until its pressure was reduced to that actually used in the high-pressure cylinder of the *Rush*, there would, on the basis that 80 per cent. of the total feed-water was utilized in such first expansion, have been obtained about 40 lbs. mean pressure and 21.3 per cent. additional work, and the cost of the horse-power would have been reduced to 15.15 lbs. of feed-water per hour, which would have required, for an evaporation of 8 lbs. of water per pound of coal, 1.89 lbs. of coal per H. P. per hour. In average practice, it is believed that the evaporation would frequently be nearer 7½ lbs. than 8, which would increase the coal consumed to, in round numbers, 2 lbs. of coal per indicated H. P. per hour.

This indirect method of procedure probably gives about the average performance to be expected under actual conditions in modern triple-expansion engines of moderate size. A better performance is claimed and undoubtedly is obtained under experimental conditions and in the larger ocean steamers. It is thought that further gain must be looked for in the performance of the boiler, as it is not believed that very much better results than 15 lbs. of water per indicated H. P. per hour may be expected.

A clear gain, however, of upward of 20 per cent. is very important, and by the same method of reasoning, it would appear that steam of still higher pressure might be expanded in still another cylinder and used again and again with economy. This corresponds with the conclusion from different premises stated in another paper presented with this, on the subject of "Cylinder Condensation, and the Reduction of the same by the use of the Compound Engine."

On the above basis, the limit of pressure would probably be fixed only by the capacity of the materials forming the steam cylinders and valve-chests to resist the higher tensions and higher temperatures. It is probable that no material better than cast-iron will be found for steam-engine cylinders, and this is made sufficiently dense to resist hydraulic pressure of several thousand pounds. Difficulty is, however, experienced in carrying pressures as high as 300 lbs. with ordinary castings, and if the steam pressure were to be increased to or beyond that point more care would be necessary in selecting and manipulating the metal and molds.

A steam pressure of upward of 300 lbs. was successfully carried on a small steamer called the *Anthracite*, which was built in England on the so-called Perkins high-pressure system, and visited this country in 1880 to demonstrate that high pressures could be safely and efficiently utilized to furnish motive power on an ocean voyage. Her machinery was tested by a board of naval officers in New York. With an average steam pressure of 316.5 lbs., expanded 25.7 times in triple-expansion engines, there was required 21.64 lbs. of feed-water per hour per indicated H. P. The engines were small, the aggregate indicated H. P. developed being but 67.7. Still the cost was quite high, no lower, in fact, than has been obtained in exceptional cases with good condensing engines, and about what ought to have been expected with an ordinary compound engine using a steam pressure no higher than 80 lbs. The same engine, tested in England by Mr. Bramwell, furnished a horse-power for 17.8 lbs. feed-water per hour, the water level being then carried lower, so that the steam was superheated considerably. The superheating of the steam at these high pressures is not desirable in practical work on account of difficulty with the packings and lubricant. In the Bidwell experiments in Boston with superheated steam, it was considered that 450 deg. was the highest temperature which should be permitted. Proper precautions would indicate that even this temperature should not be allowed in sea-going engines involving so many responsibilities. The temperature of steam of 300 lbs. pressure is about 420 deg., which, in the opinion of the writer, is as high as can be carried satisfactorily in average practice either in sea or land. It seems certain that the highest steam pressure admissible would be limited by the temperature rather than by other conditions. In some of the marine engines using steam at 160 lbs. pressure, it is found that there is a sufficient precipitation of water to permit the use of oil to be dispensed with after the engines are fairly started from port. The temperature due to this pressure is but about 370 deg. In the *Anthracite*, designed for a higher pressure, with some superheating, all the packings were made of a metal adapted to obviate the necessity of using oil, and it is believed that, if the steam be kept dry so as to secure economy, that a pressure even of 300 lbs. will not be carried in practice without the use of some device of this character; and as any specialty always acts to limit general application, a less pressure will probably be generally adopted.

It is considered by the writer that the proper limit of pressure has already been reached, if not exceeded, for the type of boiler used in large ocean steamers. Cylindrical boiler shells 12 ft. and upward in diameter, and 1⅛ to 1¼ in. thick are not recommended, although used in practice. To limit the thickness even to the figures named it is necessary to use steel; and to procure even this of sufficient tensile strength, it is necessary, for such heavy plates, to use steel comparatively high in carbon, which is treacherous under ordinary manipulation. Not a plate of it should be used without annealing after every mechanical operation performed upon it. In fact the whole boiler ought to be annealed after the plates have been riveted together in order to overcome the injurious effects due to local strains produced in working it, but this is impracticable. Of course, boilers are made as heavy as this and but few fail, but the business cannot be considered on a safe and reliable basis so long as *any* fail.

As these are notes for discussion, it is considered well to state as an opinion that, since so many manufacturers have gone into the steel business, steel can no longer be considered in a commercial sense better than iron. The element of competition brings out steel which is altogether unfitted for boiler plates. Some boiler-makers recommend their customers not to use steel, and it is only when it is carefully inspected to ascertain its quality before being made up, and also carefully inspected while the boiler is being constructed, that the steel boiler can be relied upon. It is so much more homogeneous and in every way desirable when the material is right that there is no danger of every one going back to iron; at the same time, the steel industry is bound to have its ups and downs on account of the improper material furnished by many of the manufacturers. The new ones are not entirely to blame, as some of the older ones send out inferior material under the spur of competition. It may be proper to say that no steel should be used for boilers, unless it be properly inspected or furnished by a firm which is known to keep up its reputation, and to send out nothing but what is suitable for the purpose.

The type of boiler used in the most modern men-of-war is of the locomotive type and has a smaller shell than the ordinary merchant marine boiler, and hence plates of proper thickness can be obtained without using steel so high in carbon. It would seem better to retain for these boilers the sizes now in vogue, rather than make larger ones requiring thicker plates, and also to retain substantially the thickness now in vogue, rather than to carry higher pressures requiring plates so much thicker as to necessitate the use of steel unusually high in carbon.

It is the opinion of the writer that boilers to carry the high pressures under consideration should be entirely without shells, except those of necessary separating drums with comparatively small diameters. On this system there will be no difficulty in carrying pressures as high as 400 or

500 lbs. or more if the difficulties referred to in the way of lubrication, etc., for cylinders could be overcome to permit them. Sectional boilers are so well worked out for use on land, and there has been such measure of success even in sea-going vessels, that it seems safe to conclude that the use of higher steam pressures need not be limited by difficulties in the construction of the boiler.

There is no reason why pressures as high as those in use on the western rivers, viz.: from 180 as high as 200 lbs., should not be adopted in general practice to secure economy of fuel, and the considerations above expressed in relation to the lubrication, etc., indicate that the pressure may be increased to, or nearly to, 300 lbs., when commercial and economical considerations demand such a pressure. It is probable that for pressures exceeding 200 lbs, *quadruple*-expansion engines should be used. The experiments with the *Anthracite* appear to sustain such an opinion. The writer has not seen a record of actual experiments, giving quantitative results with triple-expansion engines other than those of the *Anthracite*, though much information of a comparative nature is available which is subject to the objections first above indicated.

Accidents to Trainmen.

At the annual convention of the Master Car-Builders' Association in Minneapolis, the following report was presented by Mr. M. N. Forney, from the Committee on Accidents to Trainmen:

At each annual convention of this Association for a number of years past a committee has been appointed to make a report on accidents to trainmen. At successive meetings various excuses have been made by such committees for not presenting reports on this important subject. Within a few weeks of the date of the meeting of this annual convention, the third member of the committee had not heard from either of the two other members of the committee. As it seemed to him it would, or should, be a cause of regret if no report whatever was made on so important a subject, he determined to prepare a paper on his own responsibility in the very limited time which the duties of his official position left at his disposal. This paper or report is therefore the work of a minority of one. After it was written it was submitted to another member of the Committee, so that it has the sanction of a majority of the Committee. Owing to the haste with which it has been prepared, it does not assume to be the result of an exhaustive or adequate study of the subject, but the facts it contains and the inferences therefrom are presented to the Association, with the hope that they will excite a discussion which will suggest the direction that a more complete investigation of the subject should take in the preparation of a future report.

The last reports of the Railroad Commissioners of the States of Massachusetts, New York and Michigan show that during the year previous there were 217 railroad employés killed and 1,226 injured in these three States. From these same reports and from *Poor's Manual* we find that there were 4,856 locomotives in the railroads of these three States, and in the whole of the United States there were 25,937 locomotives. Now it may fairly be assumed that locomotives in other parts of the country do about the same amount of work that they do in the States named. If, then, 217 employés are killed and 1,226 injured while 4,856 locomotives are doing a year's work, it may be inferred, by a deduction of the single rule of three, that while 25,937 locomotives in all parts of the country are doing their work, 1,426 employés are killed and 6,548 are injured. This, then, indicates approximately the annual sacrifice of life and limb of railroad employés in this country. The calculation makes no pretense to giving accurate or precise figures, but it indicates with terrible emphasis what an awful amount of suffering, pain and anguish is due to this cause.

This is perhaps not an occasion for being pathetic, but it certainly is the duty of those who compose this Association to do all in their power to lessen the risks to which those who operate railroads are exposed. With this end in view, let us inquire what are the chief causes of injury to trainmen.

From the reports which contain the figures quoted, the following classification of the causes to which the accidents are due can be made.

STATE.	Coupling or uncoupling cars.		Train Accidents.		Falling from Train or Engine.		Various Causes.		Total.		Number of Locomotives.
	Killed.	Injur'd.	Killed.	Injur'd.	Killed.	Injur'd.	Killed.	Injur'd.	Killed.	Injur'd.	
Massachusetts	2	105	8	18	17	38	36	50	63	211	1445
New York	23	365	31	97	40	152	65	174	159	788	2583
Michigan	10	104	3	21	16	37	16	65	45	227	828
Total	35	574	42	136	73	227	117	289	267	1226	4856

In the following table the percentage which the number killed and injured, under each of the headings, bears to the total, has been calculated:

	Killed. *Per cent.*	Injured. *Per cent.*
Coupling or uncoupling cars	13.1	46.8
From accidents	15.7	11.1
Falling from trains or engines	27.4	18.5
Various causes	43.8	23.6
	100.0	100.0

This shows that nearly one-half of the injuries are from coupling cars, but that the percentage of fatal accidents from that cause is only 13.1, whereas 27.4 per cent., or more than twice as many, are killed by falling from trains and engines, but only 18.5 per cent. of the injuries are due to that cause. The large number of employés killed and injured by coupling cars, and by falling from trains will, or should naturally lead the members of this Association to inquire how this mortality and mutilation may be reduced, as the construction of cars has much to do with the risks to which the employés are exposed. Public clamor and indignation at the great sacrifice of life and limb from coupling cars, has led to the inference that it would be very largely diminished if automatic couplers were generally adopted, and much of the time of this Association has of late years been devoted to the consideration and investigation of the merits of various automatic couplers. Laws compelling the adoption of automatic couplers have been hastily enacted in various States, apparently without serious consideration or investigation of the question whether their use would materially lessen the number of coupling accidents. Owing to the large number and variety of self-couplers which have been put into use of late years, the members of this Association should now be able to know whether they lessen or increase the danger to employés.

The important question whether the risk and danger in coupling cars would not be reduced more by improvement and uniformity of non-automatic draw-gear, than by the adoption of a variety of self-couplers or the attempt to adopt one or very few kinds, is worthy of consideration and discussion by this Association. Many experienced railroad men are of the opinion that automatic couplers will not reduce the danger and the number of accidents from coupling cars. There can be no doubt that the form and construction of non-automatic draw-gear can be improved and reduced to uniformity, and that if this was done and if the standards for their height and for the dimensions for dead-blocks recommended by this Association were generally adopted, and if obvious safe-guards such as handles on the ends of cars, were generally provided, that coupling cars would be much less dangerous than it is now. The difficulties in the way of the adoption and the use of any one or even a few kinds of couplers are so great as to appear to be almost insurmountable at present. There are so many conflicting interests arrayed against each other, that at present it seems hopeless to reconcile them, and even if there were no such conflict, it does not seem that any self-couplers which could now be selected would be sure to lessen the risk of coupling cars, whereas it is certain that the improvement and reduction

to uniformity of non-automatic draw-gear would make the occupation of the brakeman less dangerous than it now is.

Furthermore, it is very desirable that the draw-gear and the ends of cars should be uniform in construction if an automatic coupler is adopted, so that if the efforts of this Association should be directed to the improvement of the non-automatic draw-gear, it would first be certain to diminish the risk of coupling cars, and next such a change will make the adoption of automatic couplers easier in the future.

Regarding accidents caused by trainmen falling from trains, the following remarks of a highly esteemed member of this Association, Mr. J. W. Marden, may be quoted. In a letter dated June 11, he says:

"I would urge upon all the members the importance of having proper appliances on all of our cars for the protection of trainmen, and having them kept in good condition. We were receiving so many cars with running-boards defective, ladder-rounds, grab-irons, steps, etc., gone, that I sent out a circular letter to different roads asking them if they would approve bills for repairs to such appliances; not that it was according to the rules, but that it was what I considered a proper charge to be made.

"We have repaired running-boards, grab-irons, handles, etc., to as high as 300 foreign cars a month at North Adams, which shows that these appliances are not watched and repaired as they should be. I am free to admit that our own cars are not up to the standard that they should be, and yet we are making every effort to bring them up, and would be glad to approve any bills for repairs of the safety appliances for trainmen."

Mr. Marden's remarks indicate that what is needed is more rigid inspection of cars. The author of this paper is not prepared to recommend any improvement in the appliances for the protection of trainmen from this class of accidents referred to, but he has no doubt that the experience of the members of this Association would enable them to point out the defects and suggest improvements in the steps, handles, railings, etc., of the cars now in use. There seems to be no good reason why a standard should not be adopted for the construction, location and proportion of such parts of cars. If uniformity could be secured there certainly would be less danger to trainmen than there is now, when nearly every car in a train is different from every other car.

The aim of this paper is to present the subject in such a way as will call out discussion, and which, as mentioned before, will indicate the direction that the inquiries of the Committee should take for a future report to guide the action of the Association.

Automatic Car-Couplers.

THE Committee on Automatic Couplers for Freight Cars presented a report to the Master Car-Builders' Convention at Minneapolis which is long and of so much value, that we regret that we can find space to give only the conclusion. The report is signed by Messrs. B. K. Verbryck, F. D. Adams, John W. Cloud, R. C. Blackall, E. W. Grieves, John S. Lentz, John Kirby, and Edward B. Wall, and their conclusions are as follows:

CONCLUSIONS.

We have now therefore reached the point in the solution of this problem, where we can say that the question which presented itself at this time last year, with reference to the value of slack, has been decided, and that consequently the choice for this Association to make is again narrowed down by a great step from between the loose link and the hooks coupling vertically, to the best subtypes of the hooks. * * * *

The Janney type of coupler, including the Janney, Dowling, Thurmond, and we think ultimately the Barnes and Hien, is the type to which the evolution of the subject has brought us; it affords a close coupling with spring slack; it makes it possible to use power train-brakes; it already includes several couplers and opens the door to more, so that no railroad company is restricted to purchasing from one manufacturer; it incorporates more of the practical requirements of a perfect automatic train connection than any other type or form of coupling. It is not a new, unknown and untried coupler; it has been used in the Janney form very extensively on some of our largest roads in the North and West, and in the Thurmond form in the South. Its most serious defect is in strength, and the question that now presents itself is, "Can this defect be remedied?" We consider that it can, and the further development of the problem must be in this direction, and what we say here on the subject of strength is applicable to all forms of couplers, no matter of what type. This development can be accomplished by following three paths:

First: Increase the dimensions.

Second: Improve the character of the material.

Third: Protect the coupler by deadwoods, or, better still, spring buffers. * * * *

Your Committee feels that the status of the problem at the present time, as here stated, warrants them in making the recommendation that this Association recommend, as a standard form of coupling, the Janney type of coupler; that the Association procure one of the present make of Janney coupler, selection being made by a committee appointed for that purpose, and then all other forms of couplers that will automatically couple to and with this coupler under all conditions of service are to be considered as within the Janney type and conforming to the standard of this Association. Your Committee trust that you will see fit to submit this recommendation to letter ballot; we make it with a full appreciation of the gravity of the situation. We have, as our past and present reports, we trust, will show, approached this conclusion with great care and consideration, and we believe that no other conclusion would be in harmony with the facts.

Our study has been based purely on the mechanical features of the problem, although we have not hesitated to consider and point out incidental advantages, not mechanical, that would result from the adoption of the Janney type. We believe that the office of this Association, and of its members, is with the mechanical department of railroading, and that what our railroads want and look to us for, is a statement of what type of coupler best fulfills the mechanical condition of a perfect train connection; when we have done this we have performed our duty, and to our superior officers belongs the question of negotiation for the use of couplers. If you approve the recommendation of your Committee, you give the railroads the type of coupler which meets more of the requisites than any other type or form. It is a type capable of fundamental duplication, already duplicated successfully, so that there is now, and we believe there will be still more opportunity for selection between several different forms of the same type.

There is an urgent necessity that the Association should act at this time, either in the line that your Committee has recommended, or in some other. Railroads have reached a point where there is an absolute need for an automatic train-coupler; it is vividly apparent that a coupler must be introduced to save the life and limb of the employes; to decrease the cost of operation by enabling the use of power train-brakes; to do away with the shocks of stopping and starting, and to eliminate the damage of bunching trains in sags and hollows.

The public demands it; the safety of the trainmen demands it, and the economical operation of railroads demands it already. Already, several corporations are acting, and more, some of them very large, are acting this year; the urgency is great and will not brook delay. If we do not agree upon some course, we will be reprehensible, for it is only by this Association that uniformity can be established, in order that all of the lives and limbs which it is possible to save will be saved; that all of the benefits in operation that it is possible to achieve will be achieved. If we do not secure this uniformity, who will be responsible for the extra risk which comes to train men when two odd couplers on a home and foreign car are brought in conjunction? Who will be responsible for the extra cost of operation that such a condition will entail? This Association. The fruit is now ripe, and if

you do not pick it it will be spoiled, for next year, numberless complications, arising from the introduction of miscellaneous couplers, will lose this Association in a mesh from which it will never be able to rise, and our opportunity to serve our fellow-men and our companies will be irrevocably lost.

In view of the facts already mentioned, that the best type of couplers is still undergoing development in matters of strength and simplicity, and that many railroads are not ready to adopt it until it is better perfected, your Committee would further recommend the continuance or use of the Marks, the Ames and the McKeen couplers as the best representatives of the loose coupler.

Freight-Train Brakes.

At the convention of the Master Car-Builders' Association in Minneapolis, the Committee on Freight-Train Brakes presented an elaborate report giving the history of the brake tests at Burlington last year and of the tests in May of this year. An interesting part of the report, on Resistance of Trains, is given on another page. Of the rest we have only space for some of the conclusions reached by the Committee, which are given below:

ELECTRICAL APPARATUS.

It seems to us the whole question of the application of electricity to railroad braking resolves itself into three important questions:

First, can a valve mechanism be made operative by electricity, which shall be permanent and practical for railroad service, not having parts too sensitive or of too fine adjustment? We think it can. The valve construction, as shown by Mr. Carpenter, the same which he used in these trials, is certainly not more delicate and complicated than that of the well-known Westinghouse triple valve.

Secondly, can the electric conductor for working these valves be so insulated and protected as to avoid short circuits and other injuries? We think it can, by running the wires inside of the air pipes, where they are as little liable to derangement and injury, and become as permanent and certain in their functions, as any other feature of the brake mechanism. In all the electric brakes shown the wires are laid inside the air-hose couplings, where they are fully protected and their connections are made from car to car easily and certainly, so that this important point is so far settled as to require no further explanation.

The remaining point is the source of the electro-motive force.

Of the different means employed by the companies represented, the secondary battery appears the most reliable, giving a constant current all the time until discharged, recharging being a simple process which can be so methodically and practically arranged as not to interfere with brake service nor add materially to the expense.

If brakes worked by electricity are to come into general use it is probable that both battery and dynamo will give way to the magneto generator, being a small machine about 18 in. square, having an easily turned crank which instantly develops the electro-motive force required, so that a turn of the crank will actually apply or release the brake. One of these machines was shown us in operation upon an engine and tender brake. This apparatus may solve a most important point connected with the application of electricity to railroad brakes, in as much as it renders the apparatus on the locomotive independent of any special stations or roundhouses or any stated period when a battery, if used, would have to be recharged.

We believe from what we have seen at the Burlington brake tests, and from close personal examination of the several electrical arrangements for braking, that electricity, properly devised and managed, may be made a valuable auxiliary to actual power brakes on long trains, and their efficiency considerably increased thereby.

GENERAL CONCLUSIONS.

At the conclusion of the 1886 trials the Committee felt that to sum up any results in the face of so large a field for improvement could not but be unsatisfactory, and while a wonderful advance has been made in the brake problem, as will be seen by a comparison of the stops of each year, the 1887 tests apparently leave the field for improvement open as wide as in 1886.

The Widdifield & Button and the Rote buffer brakes, hopeful over the shocks given by the atmospheric brakes, are fitting up or have fitted trains to pursue their investigations; the Westinghouse Brake Company, loath to accept the teachings of 1887, is making changes in valves and piping by which it hopes to make short 50-car emergency stops without objectionable shocks and without the aid of electricity; the American Brake Company, convinced that buffer brakes cannot compete with the continuous, is about testing a 50-car train fitted with a new electric atmospheric brake. While we are not prepared to make any definite recommendation at this writing as to what freight-train brake should generally be adopted, our present information, derived from the recent tests, points to two conclusions:

First, that the best type of brake for long freight trains is one operated by air, and in which the valves are actuated by electricity.

Second, that this type of brake possesses four distinct advantages.

(*a*) It stops the train in the shortest possible distance.

(*b*) It abolishes shocks and their attending damages to equipment.

(*c*) It releases instantaneously.

(*d*) It can be graduated perfectly. The further question as to whether electricity is a sufficiently reliable element to use in freight-train service is one that can only be determined by experiment, but we think the benefits derived from electricity are so manifest that the experiment is well worth trying.

In view of the foregoing, and of the improvements that the buffer and atmospheric brakes are making, your Committee recommends that the subject of Automatic Freight-Train Brakes be continued for further investigation.

Manufacturing Notes.

Riehlé Brothers, in Philadelphia, have recently received orders for a number of large scales and testing machines for various parties. These include a cement-testing machine for Princeton College and a spring-testing machine to go to London, England.

The Lobdell Car Wheel Company recently purchased the mineral rights on a tract of land containing 400 acres at Max Meadows, Wythe County, Va., for $1,000. Miners were put to work developing, and in a short time uncovered a load of iron ore of most excellent quality, and apparently great extent.

The Pennsylvania Bolt & Nut Company, of Lebanon, Pa., has recently added an artificial gas plant to the works. The furnace and gas producers were designed by M. V. B. Smith, Metallurgical Engineer, of Pittsburgh, and contain improvements whereby, it is said, the consumption of fuel is reduced to less than 250 pounds of Clearfield coal to the gross ton of iron heated.

The South Baltimore Car Company has been recently organized. The capacity of the works will be from 8 to 12 freight-cars per day. The location is at Curtis Bay on a branch of the Baltimore & Ohio Railroad, about 6 miles south of Baltimore, where a large tract of land has been secured. From 50 to 100 houses will be erected, to be occupied by the men and their families employed in the shops; streets will be laid out, paved and curbed by the time the works are in operation. The contract for the buildings has been let to Philip Walsh & Sons, of Baltimore; they will be completed by September, 1887. The buildings will be of frame covered with corrugated iron excepting the cupola-house and saw-mill, which are of brick with slate roofs. It is expected that the works will be in operation by October or November next. Mr. Wm. Keyser is President; E. Brent Keyser, Secretary and Treasurer; Howard Carlton, Manager.

Manufactures.

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THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

(Continued from page 276.)

CHAPTER V.

THE ENGINES.

SLIDE-VALVES.

The first slide-valves used at the Rogers Works were the ordinary *D* pattern. In 1853, Mr. Rogers adopted the Hack-

Fig. 165.

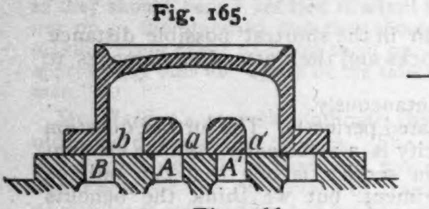


Fig. 166.

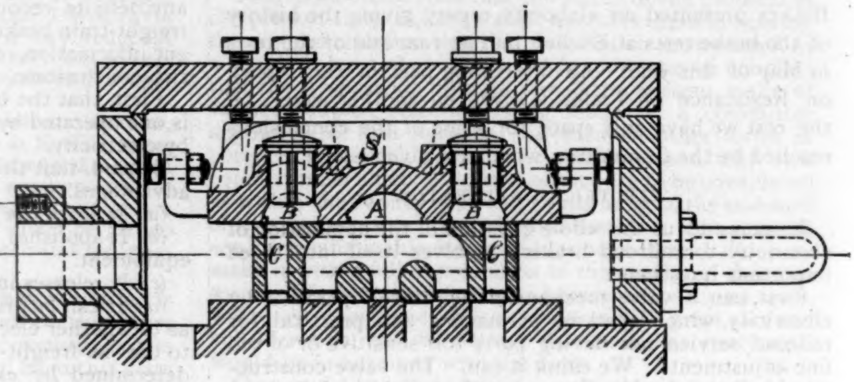


Fig. 167.

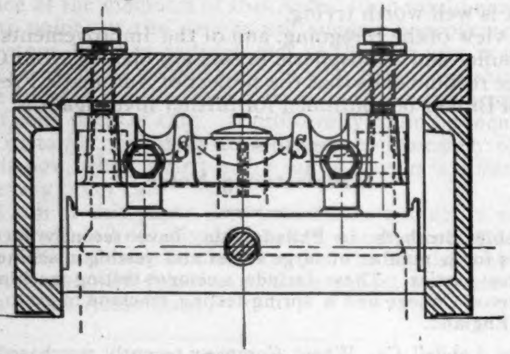


Fig. 168.

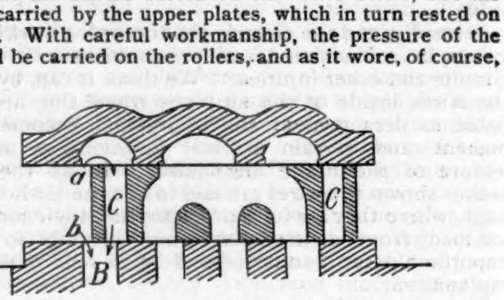


Fig. 169.

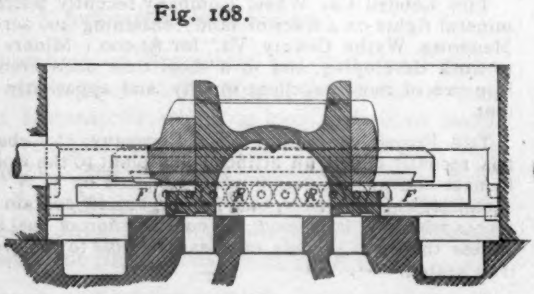


Fig. 170.

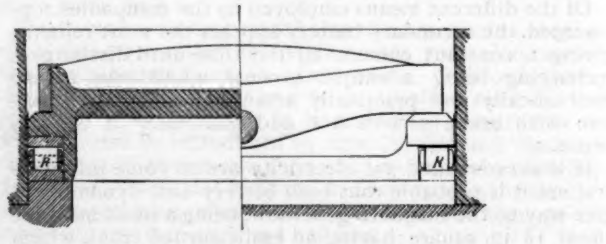


Fig. 171.

worth valve, fig. 165, with double exhaust-ports. This valve had about $\frac{3}{16}$-in. lap at *a a'*, and only $\frac{1}{32}$ at *b*. Consequently, the steam was not released at *a a'*, as shown in fig. 166, until the steam-port *B* was opened nearly $\frac{3}{16}$ in. wide at *b*. Then the two ports *a* and *a'* each commence to open. The exhaust was thus delayed, but when it did begin the steam escaped through both of the openings at *a a'*. The area of the exhaust opening was, therefore, doubled when the release occurred. This form of valve was used up to 1872 and applied to more than 250 engines, but its advantages did not seem to compensate for the increase in its area, which was due to the double ports.

In 1864, Mr. John Gleason patented a valve which Mr. Hudson afterward modified and introduced in the form shown by figs. 167 and 168. This had a saddle, *S*, on top, the position of which was regulated by set screws, as shown. The saddle had steam openings, *B B*, and an exhaust opening, *A*, on its under side. The valve had double exhaust-ports, the same as are shown in figs. 165 and 166. In addition it had two supplementary steam passages *C C*. In the position show in fig. 169, not only was the steam-port *B* open at *b*, but there was another opening at *a* through which steam passed to the supplementary port *c*, as shown by the dart, and thence to the cylinder. The opening of the steam-ports was thus doubled during the early portion of the period of admission. A similar action occurred on the exhaust side. This valve was tried, but with rather doubtful resulting advantages.

In 1868, the Bristol roller slide-valve, shown by figs. 170 and 171, was applied to a number of engines. This valve rested on a series of rollers, *R R*, placed in each side of the valve. They were connected to a frame, *F F*, their axles or spindles having a little play in their journals. Steel plates were attached to the valve on each side, and others to the valve-seat, so that the rollers rested on the latter below, and the valve was carried by the upper plates, which in turn rested on the rollers. With careful workmanship, the pressure of the valve could be carried on the rollers, and as it wore, of course, there was little or no contact between its face and seat. These valves were quite extensively introduced, but their use has been gradually abandoned.

In 1882, two forms of the Allen valve were introduced. Figs. 172 and 173 show an Allen valve with Richardson's "balanced" or equilibrium device applied to it, and fig. 172 shows an Allen valve with extensions to increase its length, and with steam-ports to admit live steam from below into the supplementary port *S S*. The Allen valve, although an American invention, was not used on locomotives in this country to any extent until after the expiration of the patent on it. It is now extensively used, and its advantages are generally recognized.

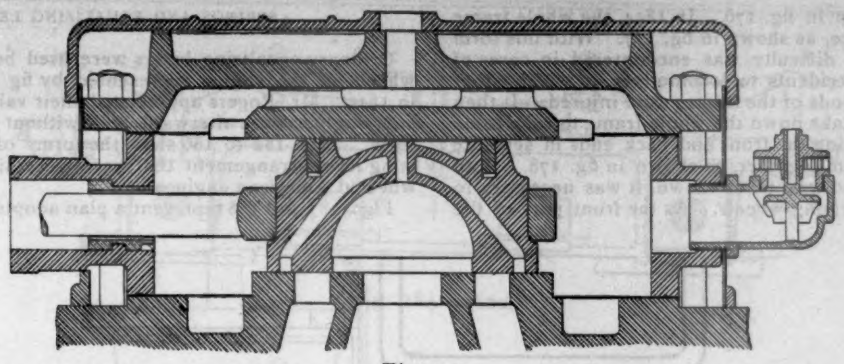


Fig. 172.

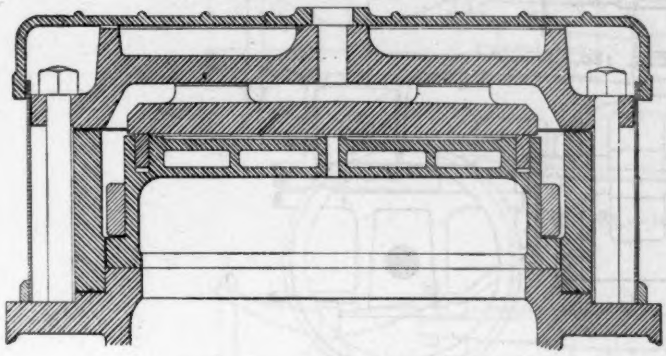


Fig. 173.

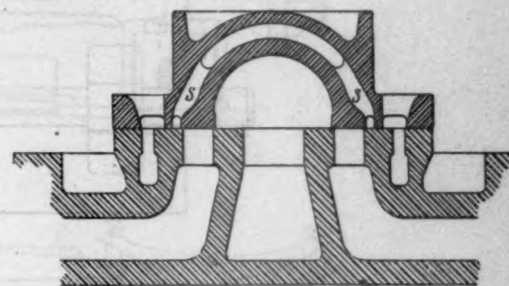


Fig. 174.

THE RUNNING GEAR.

FRAMES.

The frames used on the first locomotives built by Mr. Rogers (see figs. 12 and 14) were made of two plates, with wood filling between them. The journal bearings were outside the wheels, as shown in the figs. referred to.

Bury, who first introduced the hemispherical topped furnace in England, also used bar frames on some of his engines. It seems probable that his form of fire-box and method of con structing frames were simultaneously introduced here. There are no drawings extant of the early frames made at the Rogers Works, but in 1844 the form of frame shown in fig. 175 was used. It consisted, as will be seen, of a straight bar on top, with cast-iron pedestals bolted to it and braced at the bottom very much after the manner in use at present.

In 1850, wrought-iron pedestals were substituted for those

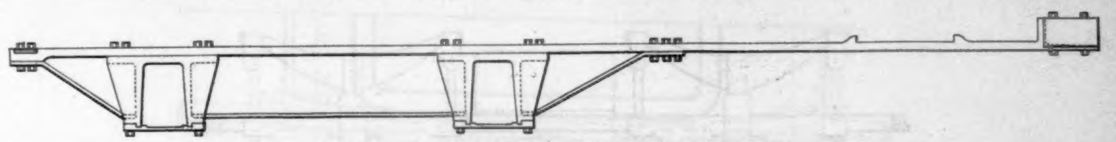


Fig. 175.

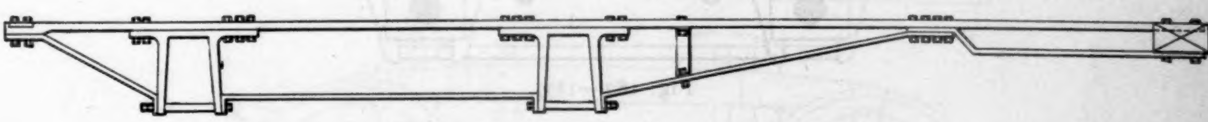


Fig. 176.

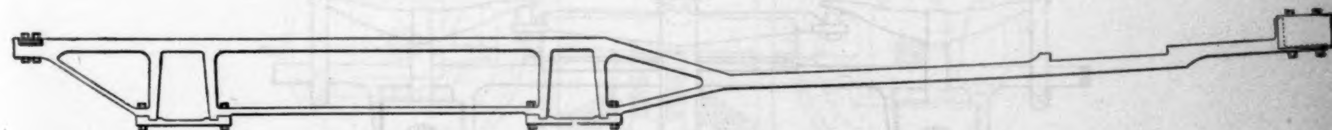


Fig. 177.

Fig. 178.

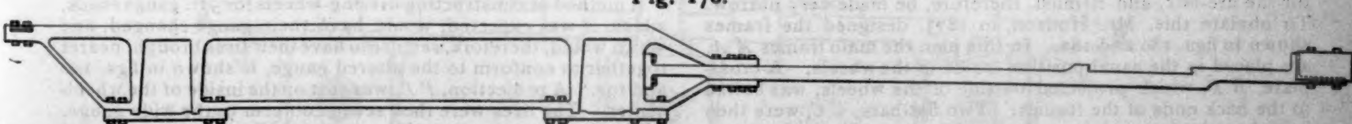


Fig. 179.

of cast-iron, as shown in fig. 176. In 1854, the whole frame was forged in one piece, as shown in fig. 177. With this form of construction some difficulty was encountered in cases of collision and other accidents to locomotives, in which either the front or the back ends of the frames were injured. It then became necessary to take down the whole frame to repair one end. This led to making the front and back ends in separate pieces and bolting them together, as shown in fig. 178. With this plan, if either end was taken down, it was necessary to remove one pair of driving-wheels. As the front part of the frame is usually injured in accidents, it was desirable to be able to take it down without removing any of the driving-wheels. The plan shown in fig. 179 was therefore adopted in 1868. In this the front end is bolted to the back end, ahead of the front pedestals, so that the front part can be removed without disturbing the driving-wheels, if it is desirable to do so. This form of construction is the one which is still used and has been very generally adopted on American locomotives.

SPRINGS AND EQUALIZING LEVERS.

Ordinary equalizing levers were used between the driving-wheels on the engine represented by fig. 18, which was built in 1845. Mr. Rogers appreciated their value, and very few, if any, engines were afterward built without using them in some form. Figs. 182 to 186 show the forms of spring and equalizing lever arrangement that were successively used for eight-wheeled American engines.

Figs. 187 and 188 represent a plan adopted for narrow-gauge engines in 1878. The purpose was to allow a wider fire-box to be used than is possible when the springs are placed alongside of it.

Fig. 189 shows the arrangement of springs used in 1880 for consolidation engines. The springs for the front axle are not shown in the engraving. Their connection with the leading truck and other applications of equalizing levers will be described further on under the head of trucks.

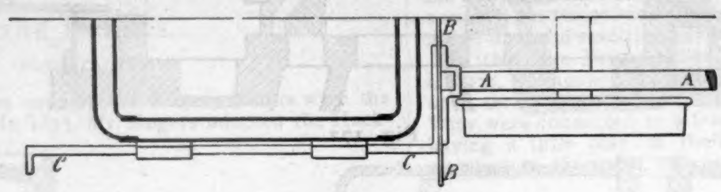


Fig. 180.

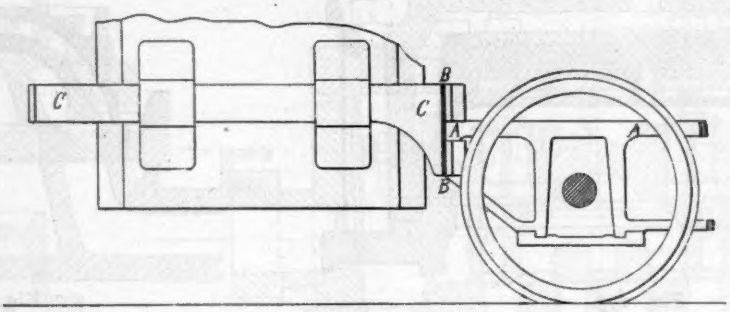


Fig. 181.

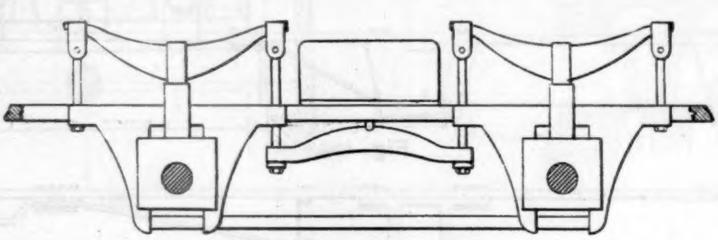


Fig. 182.—1837.

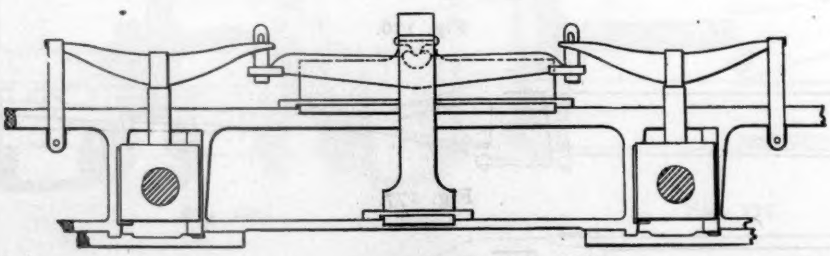


Fig. 183.—1850.

One of the difficulties in the construction of narrow-gauge engines is that there is not room enough between the frames for the fire-box, and it must, therefore, be made very narrow. To obviate this, Mr. Hudson, in 1873, designed the frames shown in figs. 180 and 181. In this plan the main frames *A A*, are placed in the usual position inside of the wheels. A cross-plate, *B B*, which projected outside of the wheels, was bolted to the back ends of the frames. Two flat-bars, *C C*, were then bolted to the cross plate, and placed far enough apart so as to give sufficient room between them for a fire-box of the width required.

DRIVING-WHEELS.

A method of constructing driving-wheels for 5 ft. gauge roads, which, it was expected, would have their gauge changed, and which would, therefore, require to have their tires brought nearer together to conform to the altered gauge, is shown in figs. 190 and 191. A projection, *P P*, was cast on the inside of the wheel-center. The tires were then set to conform to the wide gauge. When the time came to narrow it, the tires were simply moved farther in. The projection of the wheel-center which was left on the outside was then turned off, which left the wheel in proper

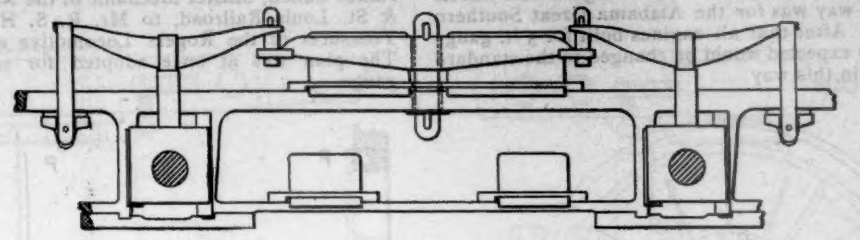


Fig. 184.—1860.

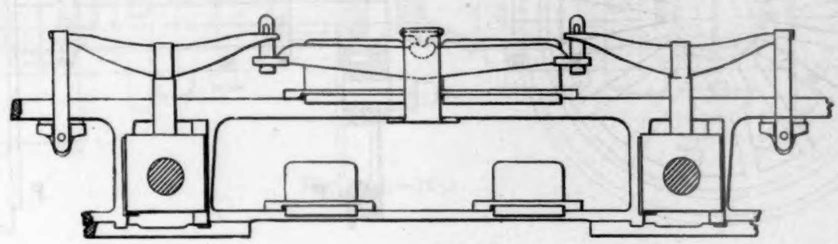


Fig. 185.—1867.

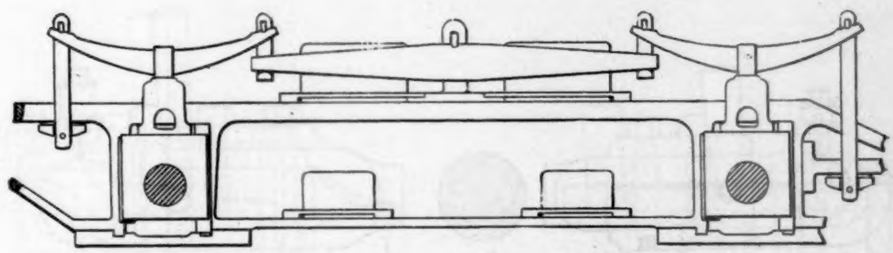
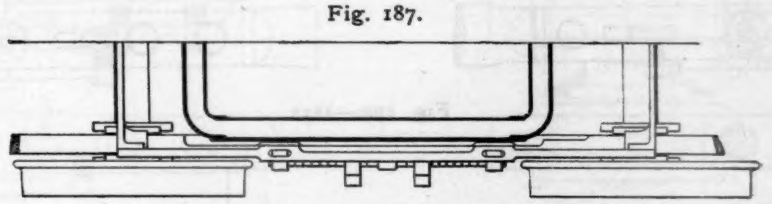


Fig. 186.—1880.

Fig. 187.



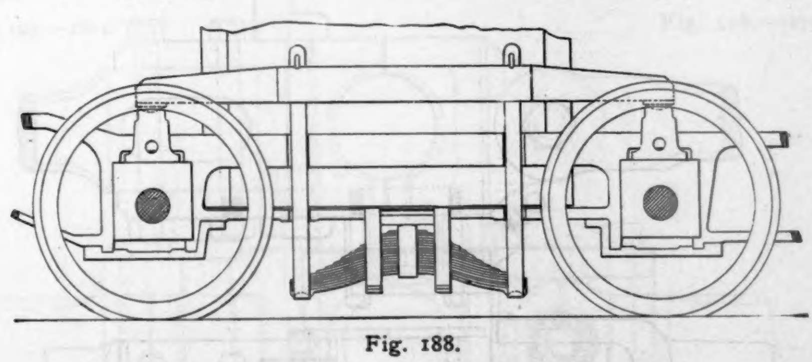


Fig. 188.

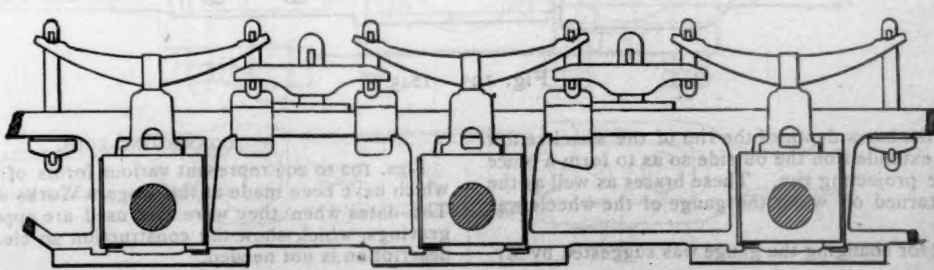


Fig. 189.

condition for the narrow gauge. The first engine with wheels constructed in this way was for the Alabama Great Southern Railroad in 1881. After that all engines built for 5 ft. gauge roads, which it was expected would be changed to the standard gauge, were made in this way.

James Cullen, Master Mechanic of the Nashville, Chattanooga & St. Louis Railroad, to Mr. R. S. Hughes, Secretary and Treasurer of the Rogers Locomotive and Machine Works. The plan was at once adopted for engines for the 5 ft. gauge.

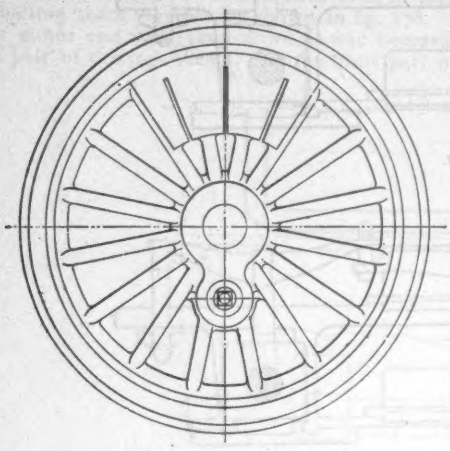


Fig. 190.

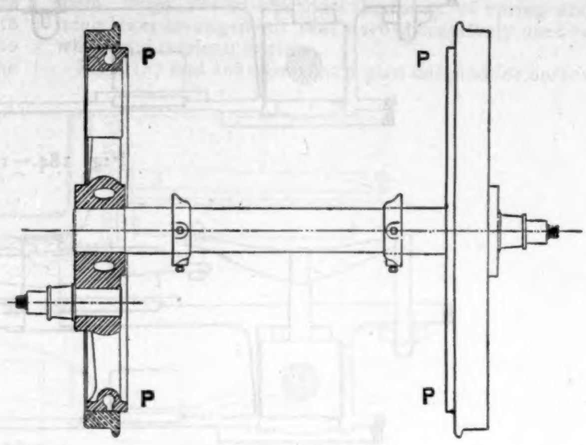


Fig. 191.

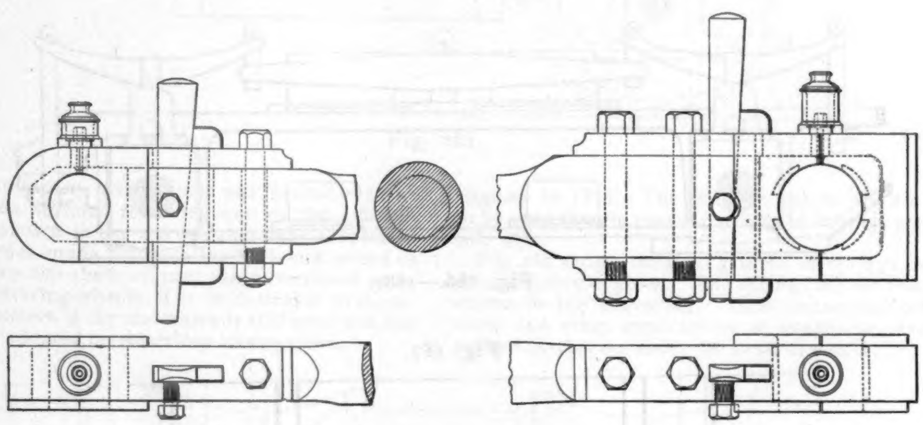


Fig. 192.—1837.

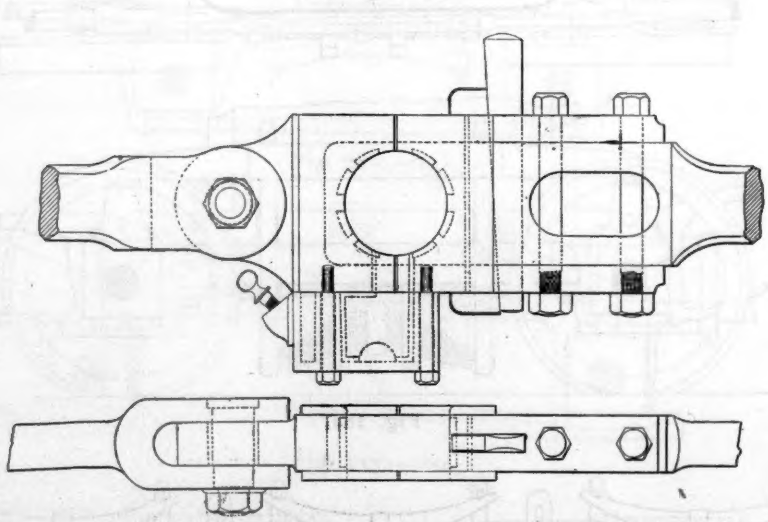


Fig. 193.—1845.

In addition to the extra depth of the rim of the wheel-center the spokes were extended on the outside so as to form a brace or support to the projecting rim. These braces as well as the projection were turned off when the gauge of the wheels was narrowed.

This expedient for changing the gauge was suggested by Mr.

CONNECTING-RODS.

Figs. 192 to 203 represent various forms of connecting-rods which have been made at the Rogers Works at various times. The dates when they were first used are appended to the engravings, which show the construction so clearly that further description is not needed.

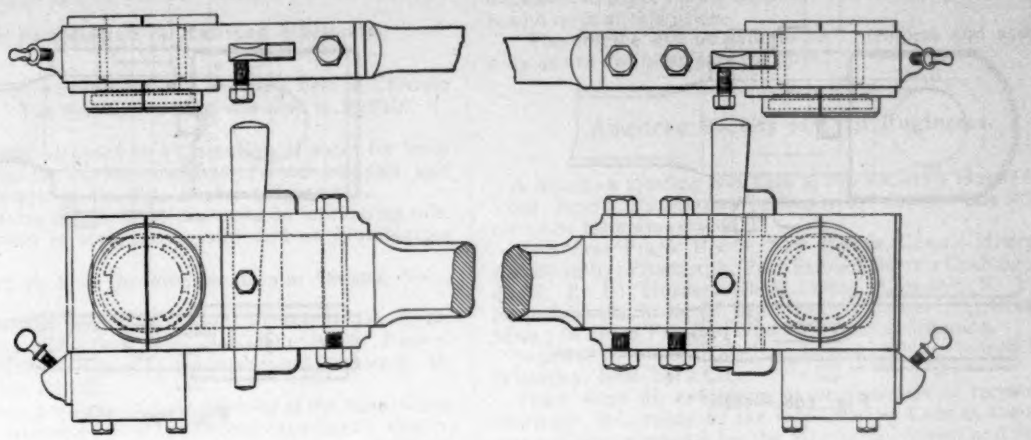


Fig. 194.—1854.

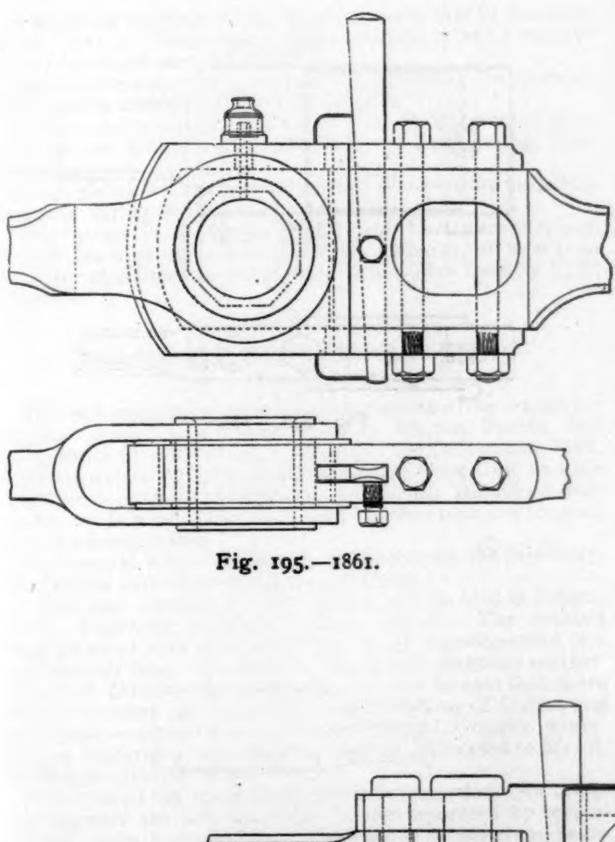


Fig. 195.—1861.

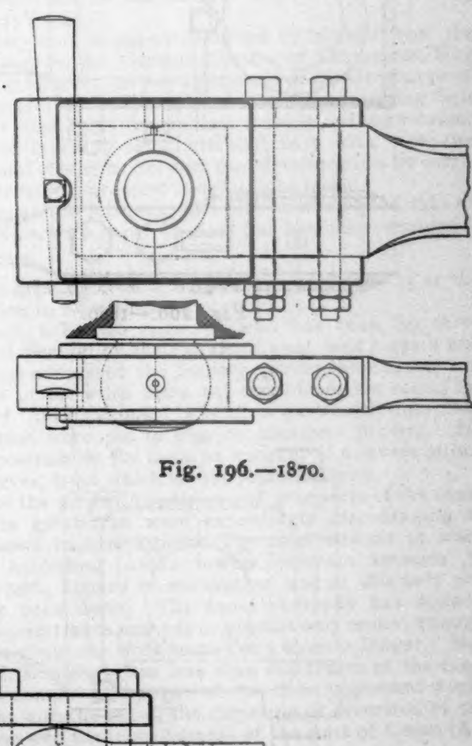


Fig. 196.—1870.

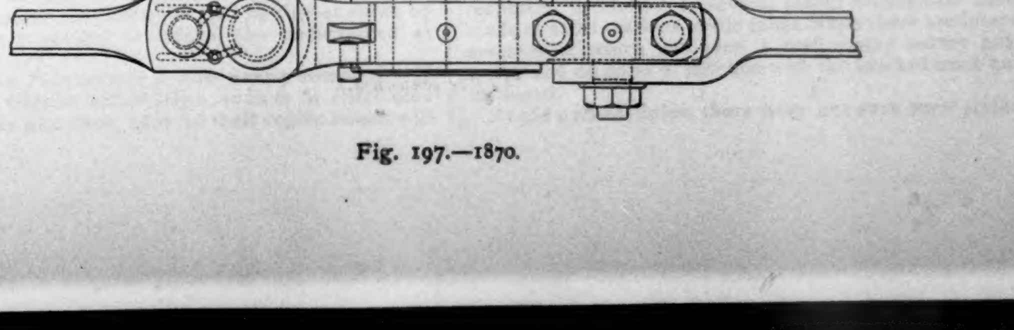


Fig. 197.—1870.

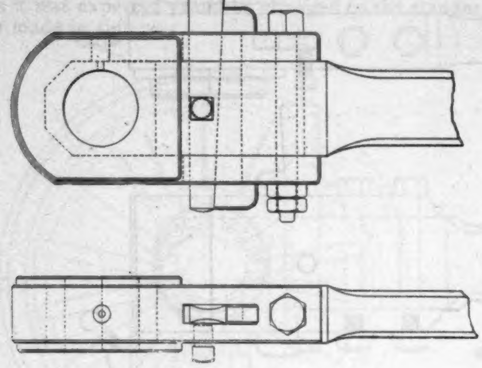


Fig. 198.—1880.

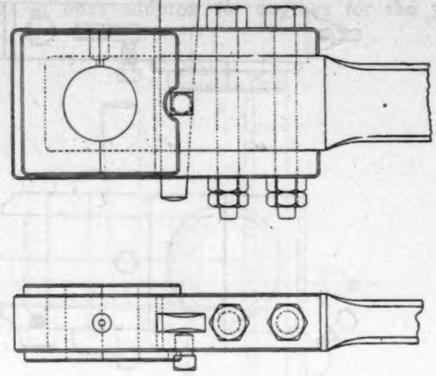


Fig. 199.—1880

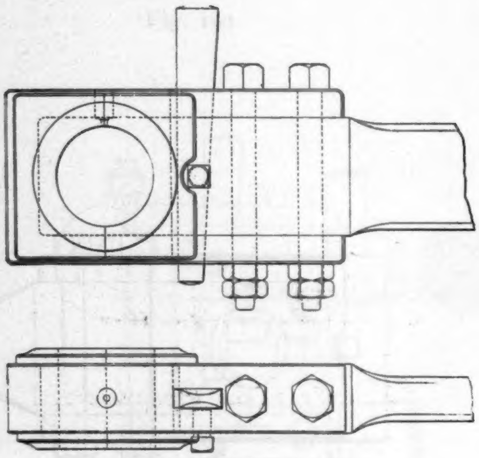


Fig. 200.—1880.

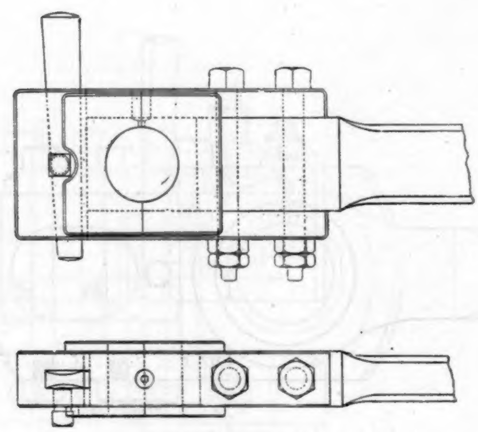


Fig. 201.—1880.

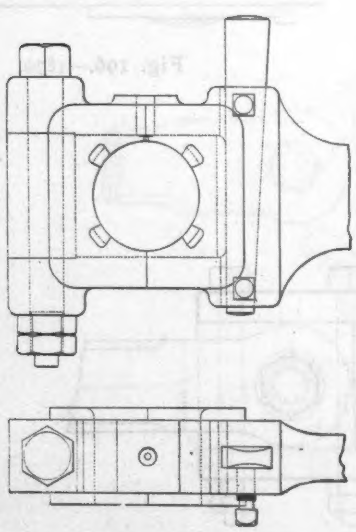


Fig. 202.—1882.

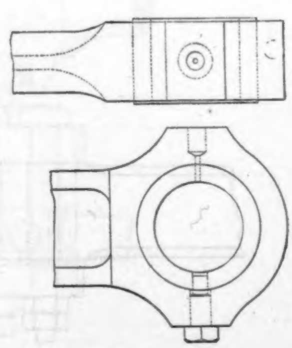


Fig. 203.—1885

(*To be continued.*)

Proceedings of Societies.

American Association of Railroad Chemists.

THIS Association was formed at a meeting held in Chicago in January last. The second meeting was held in Buffalo, N. Y., May 23.

The first day was occupied by a discussion of water for locomotive boilers and the various methods of water analysis, and by a short discussion on disinfectants for railroad use.

On the second day there were discussions on lubricating oils, on the composition of freight-car paint and on illuminating oils.

It was decided to hold the next meeting at Omaha, Neb., September 25.

The officers of the Association are: President, Dr. C. M. Cresson, Baltimore & Ohio; Vice-President, W. L. Brown, Chicago, Burlington & Quincy; Secretary and Treasurer, H. B. Hodges, Union Pacific.

The constitution provides that the sessions of the Association may be private whenever it is considered expedient; that is, whenever papers or discussions may bear upon the quality or composition of products furnished by manufacturers.

Connecticut Civil Engineers & Surveyors' Association.

A REGULAR meeting of this Association was held in Norwich, Conn., June 7. There was a large attendance and a number of new members were admitted.

The members spent a part of the day in visiting the Norwich water-works and several large factories.

In the evening a paper was read by W. H. Burnett, of Norwich, on the Relation of Photography to Engineering, illustrated by views and prints.

Notes giving facts in relation to the various works visited by the party during the day were also read.

Blue prints of Reservoir Dams and Embankments, and Anchor-Ice were distributed by W. H. Richards, of New London, and of a Break in Brick Sewer and a Plan Case by C. E. Chandler.

American Institute of Mining Engineers.

THE 48th meeting of the Institute consists of an excursion leaving Chicago July 1, and taking in Denver, Pueblo, Salt Lake, Butte City (Montana), Helena and the Yellowstone Park. Sessions are to be held at Salt Lake and Butte City, and the members joining in the excursion will reach Duluth on their return on July 24. The total cost of the excursion for each person joining is $260.

The circular from Professor R. W. Raymond, the Secretary, after giving particulars as above, continues:

"The 49th meeting of the Institute will be held at Duluth, Minn., beginning Tuesday evening, July 26. The detailed programme of this meeting will be either communicated in a later circular from this office, or handed to members on their arrival at Duluth. At present it can only be said that there will be—besides the hospitalities and pleasures of Duluth and its harbor—excursions to the Vermilion and Gogebic mines. Letters concerning this meeting may be addressed to Mr. R. S. Munger, Duluth, Minn.

"In view of the result of the above arrangements, in bringing together the two meetings usually separated by several months, there is danger that the number of papers to be included in Vol. XVI of the *Transactions* may fall below the usual average. Members are earnestly requested to prepare papers for one or the other of the meetings announced in this circular. In actual reading of papers preference will be given at each meeting to those which are descriptive of local mines, works or practice; and members residing in or familiar with the mining districts of Utah and Montana, or with the iron ranges of the lake region, are specially urged to prepare such papers. If necessary, time can be allowed after the meeting for perfecting the manuscript for publication. All members intending to have papers presented or read by title at either of the meetings are requested to inform the undersigned at once.

"Vol. XV of the *Transactions* is now nearly complete. If possible, it will be finished before July 1, so as to be distributed in July. Members who have ordered their copies bound will receive them a little later than others. Those who wish their copies bound in half-morocco but have not yet given the order, should do so at once, sending $1 to pay for binding. Volumes once sent in paper covers cannot be subsequently exchanged for bound ones at this price.

"The volume will be sent to such members and associates only as are not in arrears for dues."

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, June 1, President Worthen in the chair. The following elections were announced:

Members: Frank Bruen, New Haven, Conn.; Henry Manson Byllesby, Pittsburgh, Pa.; Samuel Barrett Cushing, Providence, R. I.; Herbert Clark Felton, Camden, N. J.; Silas Bent Russell, St. Louis, Mo.; Robert Somerville, Greenville, Miss.; William Parsons Watson, Helena, Montana.

Juniors: Benjamin Douglas, Detroit, Mich.; Joseph Yendes Wheatley, New York City.

There were on exhibition several models of turrets, gun-carriages, etc., made by the late Captain Eads at the time he was building gunboats for the Mississippi River, and now presented to the Society by his heirs.

Mr. Thompson exhibited a print of the first sleeping-car. This was a lithograph, made in Philadelphia in 1838, of Richard Imlay's "day and night car;" as stated on the print, this car was 50 ft. long, 13 ft. 8 in. high over all, and could carry 150 passengers, having 40 sleeping berths and an apartment for ladies. The car as shown was two stories high, but the interior arrangements were not indicated. One peculiarity seemed to be the attachment of the draft timbers directly to the trucks, without any connection with the body of the car. No one present was able to say whether any car was ever built after Mr. Imlay's plan.

The Secretary read a paper, compiled by himself from the latest authorities, on the German System of Permanent Way with Iron Substructure. It was an account of the German practice in the use of iron ties for railroads. Two interesting facts were stated: First, that the greatest trouble had been caused by splitting or cracking longitudinally, both with cross-ties and longitudinal sleepers; second, that deterioration by corrosion of the metal was greatest under a light traffic.

A brief discussion followed, in which it was stated that no actual experience with paper or glass ties has been recorded.

A REGULAR meeting of this Society was held June 15 at the Society's House in New York.

M. Boulangé, a French engineer, who has been for three years Chief of Section on the Panama Canal, was present and upon invitation addressed the Society, giving some account of the condition of the work upon the canal from his actual experience and observations. He also answered numerous questions which were put to him by members present. He had left his position on the canal on account of a severe attack of Isthmus fever, from which he has just recovered.

The view of the present condition and prospects of the canal given by this gentleman were exceedingly discouraging to those who desire its completion. The total amount of work to be done according to the lowest estimate amounts to 140,000,000 cubic meters of excavation, and of this only 30,000,000 have been done. The canal company has already spent 900,000,000 francs and has at present only money enough on hand to continue the work some 4 or 5 months longer. Not only, said M. Boulangé, has less than one-fourth of the excavation been completed, but two of the most important works in connection with the canal, the damming or diversion of the Chagres River and the improvement of the port of Colon (Aspinwall) have not even been touched.

There has been, apparently, a great lack of system about the work. M. Boulangé said that when he first took charge of his section he asked for a map and profile, but none were furnished him, and he subsequently ascertained that the only map in existence was one made by Lieut. Wyse from his survey, which was not in any sense intended to be a location for a canal, but merely a preliminary reconnoissance. This state of affairs has not been remedied up to the present time, and most of the engineers have been working almost in the dark on their respective sections. In several places excavations have been made of short sections of the canal, while there are intervening sections of which not even a preliminary survey has been made, and no point of junction with the finished work has been indicated.

At the port of Colon there have not even been preliminary

borings, and nothing has been done to ascertain the nature of the bottom or the possibility of improving the channel by dredging. From Colon westward the canal is now open for 16 kilometers, but of this distance the average depth attained is only two meters. Nevertheless, it is expected that there will be an official opening of this short section in the fall, when M. de Lesseps intends to visit the Isthmus. At one point of this section a dredge has been occupied for nearly a year in taking soft clay and mud from the bottom of the canal and dumping it on the bank. The ground, however, is so soft and swampy in its nature that the weight of clay thus dumped raises the bottom of the canal, and the dredge is engaged in apparently an endless tank.

The most difficult work on the canal is at the great cut at Culebra, where there will be a cutting 315 ft. deep and nearly 500 ft. wide at the top. Work has been going on for about a year, and an excavation has been made for a short distance which is now about 38 ft. deep and 70 ft. wide. An unanticipated and very singular difficulty has been encountered here in a movement of the whole mountain, which commenced as soon as work was begun upon the cutting. The cause of this is not known, and the fact has completely puzzled the engineers in charge. It was, however, predicted by the first Chief Engineer that water would be found in this cutting. M. Boulangé believes (and he stated apparently good reasons for his belief) that much of the work already done will have to be abandoned, and it is very likely that a large part of the line of the canal will have to be re-located on lines differing considerably from the Wyse survey.

In answering questions M. Boulangé said that a preliminary study had been made for a canal with locks. Under present conditions no locks could be made and no level established more than 11.8 meters above tidewater to secure a permanent supply of water, but by damming the Chagres and establishing reservoirs this limit might be increased to about 23 meters above tidewater, but the advantage gained in this way would not be very great. In relation to the regulation of the Chagres he considered it a very difficult problem on account of the great volume of water brought down by the river at certain seasons. From his own observation he has known the river to rise 21 ft. in 6 hours. Every Chief Engineer who has been connected with the canal has had a different plan for this work. The first plan proposed required a masonry dam 1,200 ft. long, 210 ft. high and 300 ft. thick at the base. This was abandoned on account of the enormous expense involved and of the uncertainty as to finding proper foundations for such a huge mass of masonry.

At present, a contract for regulating the river has been let to the *Société des Travaux Publiques*, and that society's engineers are now engaged in making surveys and preparing plans. M. Boulangé also stated that a great difficulty in the work had been the scarcity of laborers, owing to the unhealthy nature of the Isthmus. Manual work there is impossible for a white man, and the supply of negroes from the West India Islands had given out, those from Jamaica, Trinidad and the Bahamas declining to go there any more. The average mortality on the canal during one year had been 60 per cent. of all the laborers and 80 per cent. of all the white men. He said that of 72 Frenchmen, assistant engineers, clerks, draftsmen, etc., who went out to Panama a year ago, 45 were dead and only 11 were still at work; 16 of the survivors having been disabled by fever. The men who had stood the work best were negroes who were imported (probably kidnapped) from the East Coast of Africa, but they were not inclined to do much work. The Company had recently resolved to try the experiment of importing Chinamen from Hong Kong and 800 had been brought over, but no more were to be brought until it was ascertained whether these men could stand the climate, as the expense of conveying them to Panama was considerable.

On the Panama end of the canal there is a considerable stretch through low swampy ground where hardly any work has been done, simply for the reason that no man has yet been found who can work there and live.

In answer to questions again, M. Boulangé stated that the current prices paid for excavation under existing contracts were 48 cents per cubic meter for clay; $1.05 for mixed earth and rock; $1.80 for rock from 30 to 100 meters above tidewater; $2.40 for rock from the water level up to 30 meters above. The price paid for rock excavation below water level was kept secret.

A vote of thanks to M. Boulangé for his extremely interesting address was unanimously passed, and the Society then adjourned.

After the Annual Convention in the first week in July no regular meetings will be held until the first Wednesday in September.

Master Mechanics' Association.

THE annual convention began in St. Paul, June 21, First Vice-President Jacob Johann presiding. At the roll-call there were 82 members present.

After the usual addresses of welcome, Mr. Johann delivered his annual address. Some time was then devoted to appropriate memorials of the late President William Woodcock.

There was a short discussion on the use of lump, screened and run-of-mine coal. This was followed by a long and interesting discussion on the use of the straight stack and extension front smoke-box, which occupied the rest of the session.

On the second day Secretary Setchel reported 5 deaths during the year. There are now 251 active, 4 associate and 14 honorary members. Treasurer Richards reported total receipts of $1,935 and a balance of $497 on hand.

An elaborate report was presented by the Committee on Proportions of Locomotive Cylinders, which was discussed. Reports on Traction Increasers, on Piston Rod and Valve Stem Packing and on Cylinder Packing, were presented and discussed. Messrs. Stevens, Lauder and Meehan were appointed to act with the joint committee already appointed by the Master Car-Builders' Association and the Car-Wheel Makers.

On the third day the following reports were presented and briefly discussed. Locomotive Preparation; Coaling-up Locomotives; Standard Form of Tire Section; What Control has the Engineer over the Wear of Driving Wheels.

The majority report of the Committee appointed to prepare a new Constitution and By-Laws was then read, also a minority report recommending a constitution substantially like the present one. The subject, without discussion, was recommitted to the same committee with instructions to give it further consideration and report again next year.

It was resolved to hold the next convention at Alexandria Bay, N. Y., in the Thousand Islands of the St. Lawrence.

The following officers were then elected for the ensuing year, Mr. Jacob Johann having first declined the nomination to the presidency: President, J. H. Setchel; Vice-President, R. H. Briggs; Secretary, Angus Sinclair; Treasurer, George Richards.

After adopting the usual resolutions of thanks the convention adjourned.

After the adjournment the members took an excursion to Red Wing on a train drawn by the Strong locomotive *Duplex*, which was sent to St. Paul for the convention.

Engineers' Club of Philadelphia.

A REGULAR meeting was held at the Club's House in Philadelphia, June 4, President T. M. Cleemann in the chair; 18 members and 1 visitor present.

Owing to the unexpected absence of the author, the paper of the evening had to be deferred.

The evening was, however, profitably spent in a general discussion of the proportions and strengths of certain structures which can hardly be calculated with mathematical precision, such as floors built up of separate layers of boards, ribbed and perforated cast-iron chamber and manhole covers, balloon frame buildings, etc. Some interesting illustrations were presented.

A REGULAR meeting was held in Philadelphia, May 21, President T. M. Cleemann in the chair; 33 members and 4 visitors present.

There was some further discussion of the form and arrangement of the proposed U. S. Coast and Geodetic Survey Map of the Delaware and Schuylkill rivers near Philadelphia. The consideration of a resolution expressing the views of the Club was deferred till the next business meeting.

The Secretary presented two communications from Capt. S. C. McCorkle, embodying the following data on the Retardation of the Tide in the Vicinity of Philadelphia, etc.:

"Mr. H. L. Marindin, of the Coast and Geodetic Survey, gives a near *approximation* of the retardation of the tide in the frontage of Philadelphia as about five minutes of time to the mile; *i. e.*, if the time of high water was at a certain time at Fort Mifflin, the time of high water would occur five minutes later for each mile you proceeded up the river.

"Mr. Marindin sends me a little sketch, which I enclose, which shows the time it takes the tidal wave to traverse one nautical mile in the different depths of water. For example, in a bay with 60 ft. of depth of water, it just takes two minutes for the wave to go one mile. Mr. Marindin also says: 'The time of high water and low water at any place can only be determined by a long series of observations, and when the ob-

servations are taken simultaneously they have to be worked up separately, and it is a long job.'

"There has been a long series at Fort Mifflin, and the Engineers of the United States have a long series at Bridesburg, but aside from these two places I do not think there have been observations enough to determine what you want. I deduce, from the observations and conclusions, that, say at Market Street Bridge, Schuylkill, the tide would be 40 minutes later than at Fort Mifflin, and at Bridesburg, on the Delaware, just about one hour later than Fort Mifflin.

"Bench-mark at Gloucester, N. J. (C. S. Report, 1870). 'The bench-mark is the center of a triangle cut in a large block of granite which lies in a granite wall against the river. It is on the river side of the wall, about 50 yards southward from the mark on the northwest corner of the Buena Vista House. It is 7.89 ft. above mean low water, 1.62 ft. above mean high water.

"'The mean level of the Delaware River at Gloucester Ferry, from August 16 to September 8, 1870, was 3.3 ft. higher than the mean level of the sea at Keyport, N. J.' (Office data)."

The Secretary presented, for Mr. W. L. Hoyt, a Multiplication Table, from 1 to 25, for the *Reference Book*.

Mr. John L. Gill, Jr., presented an illustrated discussion as to Whether the Custom of Upsetting the Ends of Bridge Rods Should be Abandoned.

Mr. Arthur Marichal read an illustrated paper on the Construction of Reservoir Walls. After a historic prelude and some remarks about the foundations of such walls, he says:

"What profile should we adopt? This certainly depends upon the forces acting on the wall, viz., its own weight and the water pressure."

Mr. J. E. Codman presented a Diagram for the Regulation of Dimensions, etc., of Cast-iron Flange Pipes, the object being to establish, upon the basis of mathematical proportions, the diameters of flanges and bolt circles, sizes and numbers of bolts and thicknesses of metal, for different diameters of pipes.

Mr. Edward Hurst Brown described a test he had witnessed of Fire-Resisting Paint.

Mr. R. Meade Bache exhibited a Safety Self-Extinguishing Car Stove. The Club then adjourned.

Engineers' Club of Kansas City.

A REGULAR meeting was held in Kansas City, June 18.

A paper was read by Mr. A. J. Mason on Railroad Engineering in Australia.

It was resolved to make the 24-hour system the subject for the next meeting.

Boston Society of Civil Engineers.

A REGULAR meeting was held in Boston, June 15, with 31 members and 3 visitors present. Messrs. George N. Barrus and Nelson Spofford were elected members. The death of George A. Parker, an honorary member, was announced and the usual memorial committee was appointed.

A paper on the Land-slide on the Boston & Maine Railroad at Dover, N. H., in May, 1884, was read by Mr. Edward S. Philbrick.

The Society then adjourned until September.

American Society of Mechanical Engineers.

THE semi-annual meeting of this Society was held at Willard's Hotel, Washington, May 31. President George H. Babcock presided.

At the first day's session Mr. Henry R. Towne read the report of the Committee on Uniform Tests, and Mr. George M. Bond the report of the Committee on Standard Threads for Wrought-Iron Pipe, etc. The Secretary, Mr. F. R. Hutton, presented the report of the Council, which stated that, through Mr. Stephen W. Baldwin, the Society has come into the possession of much of the expert apparatus belonging to the late Mr. John C. Hoadley, of Boston. There has been added to the library the *Transactions* of the Institution of Mechanical Engineering of Great Britain from 1847 to date; also the *Journal* of the Iron & Steel Institute of Great Britain since 1873.

The following papers were presented: Tests of Comparative Value of Different Kinds of Belting, by Samuel Webber; Should a Piston Packing Ring be of the Same Thickness at Every Point, by L. H. Rutherford; Systematic Testing of Turbines in the United States, by R. H. Thurston; Helical Seams in Boiler-Making, by R. H. Thurston. The reading of these papers was followed by discussions. The consideration of various topics of interest to the profession was then begun and occupied the remainder of the morning session.

In the evening the fifth paper, by J. T. Hawkins, on Education of Intuition in Machine-Designing, was discussed by Messrs. Smith, Webber and Denton. The sixth paper, by C. E. Emery, Notes for Discussion on Cylinder Condensation, was discussed by Messrs. Denton, Stirling, Strong and Babcock. The next paper was by the same author on Notes on Limit of Pressure in Marine Engines. The eighth paper, on Comparative Value of Steam and Hot Water for Transmitting Heat and Power, by C. E. Emery, was discussed by Messrs. Porter, Stearns, Wolff and Babcock. The next paper, by Albert Stearns, on Evaporation by Exhaust Steam, was discussed by Messrs. Babcock and Miller.

In the morning of the second day a visit was made to the Bureau of Engraving and Printing, where the different operations of the printing of bank-notes was witnessed; the Smithsonian Institution and the National Museum were also visited.

At 2 P. M. a session was held, when a paper by H. R. Towne, on Methods of Determining Cost and Distribution of Heat and and Power, was presented.

The second paper was by William Kent, A Problem in Profit Sharing, which produced a long discussion on the labor question by Messrs. Hewitt, Hawkins, Towne, Doane, Stirling, Emery, Woolson, Scott, Fowler and Ashworth. The remaining portion of the session was spent in discussing topical questions.

In the evening the members attended a reception given them by Hon. Josiah Dent, on U Street.

In the morning of the third day a trip was made to the home of Washington at Mt. Vernon.

In the evening the fourth session was held. A paper was presented by H. A. Ramsay on What are the Needs of our Navy?

The next paper was by J. Morgan, Jr., on National Defense and its Mechanical Problems. The writer favored building up guns by shrinkage. Discussion followed, by Captain Roger Birney, Lieutenant Wheeler, Messrs. Stirling, Grimshaw and Emery. The session closed after a discussion of topical subjects.

Friday morning was spent in visits to public buildings, and a large number went to Cabin John Bridge, which is said to be the largest stone arch in the world.

The fifth session was in the afternoon. The first paper was by T. S. Crane, on Direct-acting Steam Veneer-Cutters. This paper was illustrated and gave a detailed description of a knife-cutting veneer machine. Discussion followed. Then followed a paper by George H. Babcock, New Method of Making Tubes from Solid Bars, which was discussed by Messrs. Hewitt, Spellman, Kent, Barker, Wilcox and Stirling. The next paper, by James Dredge, was on Gas-Lighting by Incandescence.

After a short discussion on topical subjects the convention adjourned, and most of the members left Washington for home in the evening.

Master Car-Builders' Association.

THE annual Convention of the Master Car-Builders Association opened in Minneapolis, June 14, with about 150 members present. The Convention was opened by a prayer from the Rev. Doctor Tuttle, after which, Mayor Ames of Minneapolis made an address of welcome, to which an appropriate response was made by President Verbryck.

The President then delivered his Annual Address, in which he spoke of the value derived from the conventions and the good results of the experiments which had been made under the auspices of the Association. As an outcome of these experiments there ought to be one automatic car-coupler that could be generally adopted, which would meet with little or no opposition from the various roads and the railroad commissioners.

The report of Secretary M. N. Forney showed that the Association had in 1886, 148 active, 81 representative and 2 associate members, making a total of 231. The membership in 1885 was 223. There were 580,056 cars represented in the Association in 1886, against 486,882 in 1885. The receipts for 1886 were $3,962.16 and the expenditures $3,275.53, leaving a balance of $686.63. The Association owes the Secretary $1,000, however, making a deficit in the treasury.

The usual Committees on Nominations, on Subjects for Investigation, on Correspondence, on Resolutions and on Place for the next Meeting were then appointed.

A resolution was adopted inviting members of the Interstate Commerce Commission and of all State railroad commissions to take part in this and future meetings of the Association.

The Secretary read some correspondence relative to making changes in the Christie brake shoe, which has been adopted by the Association as a standard, but it was decided that it was not advisable to make the changes. The brake shoe is now used by 15 different roads throughout the country.

The Committee on Automatic Brakes reported through Godfrey W. Rhodes, of Aurora, Ill. He referred to the tests which had been made in 1885 and 1886, and the conditions under which the tests were made of the seven or eight of the best devices, including the Carpenter, the Ames and the Card. The report reviewed these tests in detail and pointed out the defects of the various brakes. It is said there was no trouble in securing enough power, but a great deal of difficulty was experienced in securing the quick application of power. This quick application was best secured by the electrical appliances. The principal of using electrical brakes the Committee thinks is the best that has been advanced and they recommend that the Association recognize this fact, but the devices for making use of electricity they consider imperfect. Some extracts from this report will be found on another page.

The Committee on Automatic Couplers for Freight Cars, presented an elaborate and exhaustive report, the conclusions of which will be found on another page. The discussion of this report was postponed until the following day.

After the adjournment, the day was devoted by members to a visit to Fort Snelling and the Falls of Minnehaha, in carriages provided by the Local Committee.

SECOND DAY.

In accordance with the By-Laws of the Association, the morning session was occupied by a consideration of the Rules governing the Condition of and Repairs to Freight-Cars for the Interchange of Traffic. A number of minor points were brought up by members. The rule for the gauge of wheels was changed to read so that cars may be refused if their wheels measure less than 4 ft. 5 in. or more than 4 ft. 5¾ in. between flanges, or less than 5 ft. 4 in. outside treads. Some minor changes of little importance were made. A motion to make a general increase of 10% in prices for cars destroyed, was lost, having received a majority but not a two-thirds vote, and this subject of prices was finally referred to a committee.

The consideration of the Rules of Interchange was taken up again at the afternoon session and occupied a part of the time. The principal subject discussed was again the prices of cars, which were finally fixed at this time. The remainder of the afternoon session was occupied in discussing the report of the Committee on Freight-Car Couplers, which was, as might be expected, very animated. Several amendments offered were voted down, and the report and conclusions of the Committee, as presented, were finally adopted by a majority of the members present and voting. The recommendations of the Committee as to a standard, will, however, under the Rules of the Association, have to be submitted to a letter ballot.

THIRD DAY.

At the third day's session a report from the Committee on Accidents to Trainmen was submitted. This report we print elsewhere.

This report called out a long and animated discussion, the burden of which was that more careful inspection of cars and greater attention to keeping the minor appliances in order were needed. Naturally, a good deal in relation to couplers was said in this discussion, and the general opinion was that the introduction of a diversity of couplers had increased the dangers to trainmen.

The report of the Committee on Standard Draw-gear for Non-automatic Couplers was presented, and after some discussion adopted.

The Committee on Standard Sizes of Lumber for Car Construction presented a report, which was received and the recommendations ordered to be submitted to letter ballot.

The Committee appointed to present a Standard Truck and Axle for cars of 60,000 lbs. Capacity, submitted plans and drawings. This report was likewise received, and the plans ordered to be submitted to a letter ballot.

The Committee on Car Roofs presented a report, which was received and the subject was ordered to be carried over for another year.

The Convention having ordered, in response to a request presented, that a committee be appointed to confer with other committees to be appointed by the car-wheel makers of the country and the Master-Mechanics' Association, in relation to matters pertaining to the construction and use of car-wheels, the President appointed Messrs. J. N. Barr, John Kirby, and George F. Wilson to represent the Master Car-Builders' Association on this Joint Committee.

In view of the limited time remaining, and of the fact that many experiments are at present in progress, the results of which have not been yet determined, the subject of Car-Heating was continued over for a year.

It was voted that the Convention of 1888 be held at Alexandria Bay, N. Y., in the Thousand Islands of the St. Lawrence River.

The business of the Convention was then closed by the adoption of the usual routine resolutions as presented by the committee, and by the election of the following officers.

President—Wm. McWood, Grand Trunk, Montreal, Can.

Vice-Presidents—J. W. Cloud, New York, Lake Erie & Western, Buffalo, N. Y.; E. W. Grieves, Baltimore & Ohio, Baltimore, Md.; John S. Lentz, Pennsylvania & New York, Packerton, Pa.

Treasurer—John Kirby, Lake Shore & Michigan Southern, Cleveland, O.

Executive Committee—Robert C. Blackall, Delaware & Hudson, Albany, N. Y.; R. D. Wade, Richmond & Danville, Richmond, Va.; Joseph Wood, Pennsylvania Company, Fort Wayne, Ind.

After the adjournment of the Convention, the Executive Committee held a meeting and re-elected M. N. Forney Secretary of the Association for the ensuing year.

PERSONALS.

Mr. J. G. Motley has been appointed Chief Engineer of the projected Louisville Southern Railroad.

Mr. J. W. Deen is Engineer in charge of the Aspen Extension of the Denver & Rio Grande Railroad.

W. F. Bradley is now Master Mechanic of the Kanawha & Ohio Railroad. His office is at Charlestown, W. Va.

Mr. J. C. Rhawn is Engineer in charge of construction of the new Clinch Valley line of the Norfolk & Western Railroad.

Mr. T. J. Nicholl has been appointed General Manager of the Natchez, Jackson & Columbus road, with office at Natchez, Miss.

Mr. A. H. Salisbury, late Assistant Engineer, has been appointed Superintendent of Water Works at Lawrence, Mass.

Mr. H. V. Conrad, formerly on the West Shore road, has accepted a position with the Hinkley Locomotive Company in Boston.

Mr. C. M. Cook is appointed Engineer of Maintenance of Way of the Norfolk & Western Railroad, with office at Roanoke, Va.

Mr. J. W. Clarke has been appointed Engineer in charge of road, bridges and buildings of the Gulf, Colorado & Santa Fe road.

Mr. P. H. Peck has been appointed Master Mechanic of the Chicago & Western Indiana Railroad, with office in Chicago.

Mr. F. A. Garvey has resigned his position as Chief Engineer of the Texas & Pacific road, and will engage in business as a contractor.

Colonel James Andrews, of Allegheny, Pa., will it is said, succeed the late Captain Eads as Chief Engineer of the Tehuantepec Ship Railroad.

Mr. C. R. Meeker has been appointed Superintendent of the Oregon Pacific Railroad, with office at Corvallis, Oregon, succeeding F. C. Berell.

Mr. Lewis H. Morse has resigned his position as Superintendent of Bridges and Buildings of the Kansas City, St. Joseph & Council Bluffs road.

Mr. Wm. A. Kellond, Assistant to the General Manager of the Louisville & Nashville road, has resigned that position to go into the iron business in Louisville.

Mr. George L. Chatfield has been appointed Assistant General Master Mechanic of the Chicago, Rock Island & Pacific Railway, with office in Chicago.

Mr. H. G. Holden, late Superintendent of the water-works at Lowell, Mass., is now General Superintendent of the works of Turner, Clark & Rawson, of Boston.

Captain C. B. Percy, late Assistant Engineer of the Mobile & Birmingham Railroad, has resigned that position and is now Assistant Engineer on the Mobile harbor improvements.

Mr. C. W. Lawler has been appointed Superintendent of the Mahanoy Division of the Philadelphia & Reading Railroad. He was recently on the Chicago & Northwestern road.

Mr. Marvin Hughitt, late Vice-President and General Manager of the Chicago & Northwestern Railway Company, has been chosen President in place of Mr. Albert Keep.

Mr. Samuel L. Minot has been appointed Engineer of the Boston & Providence Railroad, and will have charge of track, buildings and bridges. The office is a new one on this road.

Mr C. H. Meade has been appointed Superintendent of the Car Department of the Texas & Pacific Railroad, with office at Marshall, Texas, in place of F. M. Alexander, resigned.

Mr. H. J. Small is appointed Assistant Superintendent of Motive Power of the Philadelphia & Reading road, with office in Reading, Pa. He will have immediate charge of the Reading shops.

Mr. Charles S. Churchill has been appointed Engineer of Maintenance of Way of the Shenandoah Valley Railroad, with office at Milnes, Va. He was recently on the Pennsylvania Railroad.

Mr. Charles H. Morgan, for many years General Superintendent of the Washburn & Moen Manufacturing Company, at Worcester, Mass., has resigned his position that he may obtain much needed rest.

Mr. W. J. Sherman, Assistant Chief Engineer of the Gulf, Colorado & Santa Fe road, is relieved from charge of maintenance of way, and will give his entire time to supervising the building of new road.

Mr. Howard Murphy, Secretary of the Engineers' Club of Philadelphia, and a con ulting engineer of large practice in Philadelphia, has been appointed a member of the Pennsylvania State Board of Health.

Mr. N. Slingland, Superintendent of Motive Power of the Housatonic Railroad, retired from that position June 20. Mr. Slingland states that he did not resign, but was discharged by the Vice-President, no cause being given.

Professor A. S. Bolles, of Philadelphia, has been appointed Chief of the Bureau of Industrial Statistics of Pennsylvania. He is at present professor in the Wharton School of Finance of the University of Pennsylvania.

Mr. C. W. Bryan, Principal Assistant Engineer of the Edge Moor Iron Company, has resigned that office to accept a position in the bridge department of the Missouri Pacific Railway. His office will be at Washington, Mo.

Mr. A. A. Hobart, formerly Superintendent of the Boston & Lowell and at one time on the Chicago & Northwestern, is reported to be dangerously ill in Boston. He had served also with the Wabash and the Chicago, St. Paul, Minneapolis & Omaha.

Mr. Albert Keep, for many years President of the Chicago & Northwestern Company, has retired from that position, desiring to relinquish the active management of the company on account of increasing age. He has been chosen Chairman of the Board of Directors, a new office.

Brevet Major General John G. Parke, Colonel U. S. Engineers, has been detailed to the command of the Military Academy at West Point, to succeed Brigadier General Merrttt, who is relieved. General Parke has been for a number of years employed on river and harbor improvement work, in which he has had an extended experience.

The Brooks Locomotive Works, at Dunkirk, N. Y., have issued a circular dated June 9, 1887, in which they say: "In officially announcing the death of Mr. H. G. Brooks, the founder of the Brooks Locomotive Works, which occurred on April 20, 1887, we beg to announce the following as the present list of officers: Edward Nichols, President; M. L. Hinman, Vice-President and Treasurer; T. M. Hequembourg, Secretary; J. H. Setchel, Superintendent; R. J. Gross, Agent."

NOTES AND NEWS.

Railroads in Sumatra.—The Dutch Government has had surveys made for a railroad in the island of Sumatra, which will be nearly 150 miles long. The chief object is to develop the coal fields on the Umbile River.

Pennsylvania Railroad Relief Department.—The statement of the Relief Department for April shows total payments for the month of $24,543. From February 15 to April 30, the number of death benefits paid was 237; accident benefits, 2,956, sick benefits, 6,537.

Improvements in Puddling.—A new puddling process is on trial in Pittsburgh, by which double the usual amount of metal can be worked at one heat. The use of natural gas makes it possible to produce an even heat over the whole of the large chamber which is substituted for the old furnace.

Electric Motors in Pittsburgh.—Several Pittsburgh gentlemen have organized the Pittsburgh Electrical Motor Company to build and operate motors for passenger railroad lines. The capital stock is $100,000. The following gentlemen are interested in it: Messrs. John E. Ridall, Jas. B. Scott, Oliver Scaife, Geo. L. McFarlane and A. M. Neeper.

Transmitting Power by Water.—The London Hydraulic Power Company's operations now cover a considerable district. There are 20 miles of main pipe laid, in which a pressure of 700 lbs. is constantly maintained. In March last there were 458 machines of different kinds worked by the water-pressure furnished by the Company, an increase of 110 within a year.

A Fast Steamer.—The new steamer *Queen Victoria*, built on the Clyde by the Fairfield Shipbuilding Company, made her first sea trip recently from Greenock to Liverpool. The run was made in 9 hours 23 minutes actual steaming time, or at an average speed of 25.6 miles per hour, in weather not very favorable to speed. The ship is to run between Liverpool and the Isle of Man.

Iron Cars for India.—A correspondent of the London *Engineer* says that the Midland Railway Carriage & Wagon Company has secured an order for 325 wagons for one of the Indian lines. The wagons are made almost wholly of steel and iron, the proportion of wood employed being very trifling. Another company has an order for 300 wagons of a similar character for an Indian road.

Washington Heights Viaduct.—A bridge or viaduct is to be built from the Elevated Railroad station at 155th Street in New York across a strip of low ground to the high ground known as Washington Heights. This viaduct is to be of iron and will be 1,845 ft. long and 50 ft. wide, having a roadway 30 ft. wide and two 10-ft. sidewalks. The viaduct will have a grade of 1 in 20 from the station up.

Heavy Locomotive Mileage.—During the month of May, locomotive No. 317 on the Philadelphia, Wilmington & Baltimore Railroad ran altogether 17,360 miles in passenger service. This is claimed to be the heaviest mileage on record in regular service. The locomotive made two trips each way daily between Philadelphia and Washington, and was run by four different crews, each crew making one trip.

Pressure and Temperature in Artesian Wells.—Heavy machinery is run by artesian-well power in many parts of France, and the experience of the French shows that the deeper the well the greater the pressure and the higher the temperature. At Grenelle, a well sunk to the depth of 1,802 ft., and flowing daily 500,000 gallons, has a pressure of 60 lbs. to the square inch, and the water from this well is so hot that it is used for heating the hospitals in the vicinity.

An Electric Yacht.—At the Royal Albert Docks, London, May 14, the electric yacht *Countess* was launched. The yacht has been built by Lester & Perkins for the Electric Locomotive & Power Company, of London. The boat is 90 ft. long, 11 ft. 6 in. beam and 5 ft. 6 in. deep; she will draw about 3 ft. of water. The motive power will be supplied by Elieson storage cells, and the screw will be driven by an Elieson motor, of the pattern which has already been employed with some success for street car traction.

Russian Oil Pipe Line.—The capacity of the railroad line from Baku to Batoum, Russia, the chief traffic of which is in petroleum, is limited by the very heavy grades at the Suram Pass, where two engines are required to haul a train of 6 tank cars. It is now proposed to put in a pipe line over the pass to help the railroad. Trains from Baku will deliver the oil into tanks at Michaelova, whence it will be pumped to tanks at Kirrilli and thence delivered into tank cars again. The pipe line will be 35 miles long.

Splice-Bars.—Messrs. Morris, Sellers & Co., of the Chicago Splice-Bar Mill, have lately received large orders for the Samson Splice-bar. This joint is used exclusively on the new Minneapolis, Sault Ste. Marie & Atlantic road and its branches. Large orders have also been received from the Kansas City, Memphis & Birmingham and the Atchison, Topeka & Santa Fé; the last-named company has this splice-bar in use on nearly 2 600 miles of track. In all, the Samson joint is now in use on 12,000 miles of track on 170 different roads.

Chicago Water Works.—A plan for the increase of the water supply of Chicago has been prepared by City Engineer J. G. Artingstall. It provides for a tunnel 8 ft. in diameter extending 4 miles out into the lake, and connecting with a

shore tunnel 10 ft. in diameter extending from Grosse Point to the city, a distance of 14 miles. It is thought that the lake tunnel will reach a point where the water is free from sewerage. The capacity of the tunnel will be abont 80,000,000 gallons a day, and the estimated cost is about $4,000,000. It will take some three years to build the tunnels.

Steam Bell-Ringer for Locomotives.—An apparatus for ringing the bell by steam has been placed on several of the passenger engines on the Grand Rapids & Indiana Railroad. It consists of a small steam cylinder placed at one side of the bell-frame and resting on the boiler. The connecting-rod, which connects the piston to a 3-in. crank on the bell, is so constructed that it will vary its length according to the swing of the bell, thus removing the liability of knocking the cylinder head out by the piston coming in contact with it. It is manufactured by Cooke & Strong, of Danville, Illinois.

The Siberian Railroad.—Work on the main line of the Siberian Railroad is advancing rapidly, and the section from Tekaterinberg to Tjumen is nearly completed. In the estimates of the traffic expected for this road are included yearly some 49,000 tons of wheat from Tomsk; 20,000 tons of iron, lead and copper from the mines of the Altai Mountains and Western Siberia. There are also large deposits of coal and salt, not worked at present on account of the lack of transportation, which will be opened when the railroad reaches them. It is also expected that the railroad will develop the overland trade with China and Turkestan.

International Railroad Congress.—The International Congress, which was organized at Brussels in 1885, will hold its second meeting at Milan (Italy), on September 17 next. The object of the Congress is to make and maintain rules for the exchange of business among the railroads of the different European countries. An agreement will be presented for ratification, under which a central office will be established at Berne (Switzerland) for the adjustment of traffic questions, settlement of disputes, claims for loss and damage and similar matters. The want of such an arrangement has long been felt by European railroad officers.

Baltimore & Ohio Employes' Relief Association.—The April sheet of this Association shows payment of benefits to members as follows:

	Number	Amount.
Accidental Deaths	4	$4,000
Accidental Injuries	289	3,769
Natural Deaths	7	4,000
Natural Sickness	495	8,003
Physicians' Bills	157	883
Total,	952	$20,655

The payments to members for seven years—May 1, 1880, to April 30, 1887, have amounted to $1,383,983, in all.

Petroleum in Burmah.—Upper Burmah, recently annexed by the English Government, contains petroleum wells which have been worked after a fashion, and from which oil has been obtained in small quantities for a very long time, probably over a thousand years. None of the present wells are over 200 ft. deep, and the oil is raised to the surface by hand. English papers state that analysis has shown that the oil is of good quality, and that arrangements are in progress for developing the wells and testing the productive capacity of the region. The oil field best known is on the Irrawaddy River, only 60 miles from the present terminus of the railroad from Rangoon. It is believed that oil can be found over a large district.

Copper Production of the World.—The production of copper in the world for three years past is estimated as follows, in tons:

	1886.	1885.	1884.
Europe,	76,463	76,551	75,410
North America,	73,780	77,706	66,750
South America,	40,008	44,573	48,269
Africa,	6,125	5,700	5,260
Asia,	10,000	10,000	10,000
Australia,	9,700	11,400	14,100
Total,	216,076	225,930	219,789

Of the North American production last year, 69,805 tons are credited to the United States; 3,125 to Canada and Newfoundland and 850 tons to Mexico.

Compound Passenger Locomotive.—A new compound passenger locomotive has been just completed for the Northeastern Railway (England) by Mr. T. W. Worsdell. The engine is inside-connected, the two cylinders being connected to the crank axle in the same way as two ordinary cylinders. There are two pairs of drivers connected, 6 ft. 8¼ in. diameter, and one pair of leading wheels, 4 ft. 7¼ in. diameter. The high-pressure cylinder is 18 in. and the low-pressure cylinder 26 in. diameter; both 24-in. stroke. The valve-motion is on the Joy system. The engine weighs 43¾ tons, the main drivers carrying 18, the trailing-wheels, 12½, and the leading-wheels, 12¾ tons.

A Large Dam.—It is proposed to enlarge the capacity of the water-works supplying San Francisco, and the plan adopted includes the construction of a dam which will be, probably, the largest in the world. This dam will be built across the upper end of the San Mateo Canon, about 4½ miles west of the town of San Mateo, Cal.; it will be 700 ft. long, 170 ft. high, 175 ft. thick at the base, 20 ft. thick at the top.

This dam will make the head of the canon a great storage reservoir, having a capacity of about 32,000,000 gallons. It is claimed that the water collected and stored there will be very pure. The connection between the reservoir and the present water-works will be an expensive work, including a tunnel about 4¾ miles long.

Railroads in Japan.—A German authority gives the condition of railroads in Japan as follows, about the middle of 1886:

	Gov't.	Private.	Total.
In operation	227	120	347
Under construction	68	42	110
Surveyed and located	91	155	246
Projected	100	336	436

Contracts have recently been let in Germany for rails and rolling-stock. A few locomotives have been built in the United States, and there has been some talk recently of further orders coming here, but we have not heard anything definite about the matter.

The Action of Nitrogen on Iron.—Mr. H. N. Warren has subjected specimens of fine merchant iron to the action of nitrogen in ammonia gas while at a bright red heat, and found that on cooling it showed an intense white surface, with increased hardness. Its fracture was crystalline, and resembled that of siliconized steel. It also showed the presence of nitrogen under analysis, through the formation of ammonia. Copper bars also showed similar changes when subjected to nitrogen in the same way. Some of the bars split upon being brought into the atmosphere before they were cold. Mr. Warren thinks this phenomenon due to their absorption of ammonia while heated, and expulsion of it when cooled; an effect similar to the absorption of oxygen by silver.

Brake Patent Suits.—The Westinghouse Air Brake Company and George Westinghouse, Jr., have begun suits against J. F. Carpenter, the inventor of the Carpenter air-brake, for infringement of the Westinghouse patents. The complaint charges that the Carpenter brake, as exhibited at Burlington, is an infringement in several points, the chief ones being the couplings, the brake valve, the train-pipe and the brake cylinder. Mr. Carpenter claims that he has a full defense.

The case will be heard by the United States Circuit Court at Keokuk, Ia., at the July term. Similar suits have been tried in England and Germany, but the Carpenter brake as there used differs considerably from the brake on trial at Burlington, so that the present case is substantially a new one.

A New Coasting Steamer.—The new steamship *Winthrop*, built by the New England Shipbuilding Company to run between New York and Portland, is equipped with boilers and engines from the New England Iron Works, the machinery being designed by the Superintendent of the works. Her engines are triple-expansion, with cylinders 22, 36 and 55 in. in diameter and 36 in. stroke, and intended to run at a speed of 90 revolutions per minute. She has a surface condenser weighing 8 tons. Her propeller is 12 ft. in diameter, and weighs 5,600 lbs. The two boilers are 10 ft. in diameter and 24 ft. long, both of extra quality steel, and calculated to carry a working pressure of 150 lbs. to the square inch. There are three circular furnaces in each boiler. The consumption of coal will be 13 tons in 24 hours.

Kentucky Mineral Deposits.—The report recently issued by the Geological Survey of Kentucky, on the geology of Elliott County, discusses the coal measures of that region, and especially the massive conglomerate, which, along certain uplifts, has been deeply trenched by the streams, the vertical walls of the narrow and exceedingly picturesque gorges ranging from 75 to 175 ft. in height. We also find here full accounts by Messrs. Crandall and Diller of the trap dike of Elliott County, which is noteworthy as being the only mass of eruptive rock yet discovered in Kentucky, and of the interesting possibilities in the way of diamonds suggested by Professor Lewis. But, although this peridotite is similar to that so closely associated with the diamonds in South Africa, Mr. Diller finds no facts which would warrant a persistent search for the gems in Kentucky.—*Science.*

Induction Telegraph For Trains.—The Consolidated Railway Telegraph Company, which now possesses all of the patents covering telegraphing by induction to and from mov-

ing trains, and also contracts with the principal inventors covering future improvements.

Negotiations are pending between the new company and several prominent trunk lines, and it is prepared to open negotiations with railroad companies in the United States and the Canadas for the application of its improved combined system of railway telegraphing upon very favorable terms.

The new "Duplex" feature of the system deserves careful investigation and attention, as by its means one wire may be used for telegraphing simutaneously between stations and between moving trains and stations, thus obviating in many instances the use of any other telegraph line.

An Iron Lighthouse.—The Colwell Iron Works in New York have just completed an iron lighthouse for the Government. It is for Anclote Key, on the west coast of Florida. It is a skeleton lighthouse, 106 ft. high from the base to the top of the lantern chamber. It consists of a hollow central shaft, 6 ft. 6 in. in diameter, secured by heavy posts fastened with radial struts and stiffened by wrought-iron, diagonal tie bolts. When in position it will have a concrete foundation 4 ft. deep and 38 ft. square. The lantern chamber is reached by a spiral iron staircase inside the central shaft. The doorways and windows are solidly storm-proof. Just below the lantern chamber is the watch room, whence the oil is pumped to the lantern. This room is lighted by port-holes in the floor, solidly glazed. The lantern chamber itself is octagonal in shape and about 10 ft. high. The light and the glass sides of the chamber are being made in France. The lighthouse will cost the Government $11,000, and weighs only 75 tons.

The New Cruiser "Atlanta."—The last report of the Naval Advisory Board on the *Atlanta* states that the vessel on her six hours' speed trial developed a collective horse-power only 4.1 per cent. below the requirement of the contract, and that this failure was not due to defective material or workmanship, with the exception of a slight defect in the arrangement for oiling the crank-pins. The Board suggests a few additional changes and improvements, which have been ordered to be carried out by the bureaus.

The entire battery of the ship, including both the 6 and 8-in. guns and their carriages, with steam gear for the latter, are complete. In fact the ordnance officers finished their work on her several weeks ago, and as her ammunition is ready at Ellis Island, no delay in her departure for sea can result on account of her armament. The work recommended by the Advisory Board, including new braces necessary for her boilers, will involve about a month's attention at the New York Navy Yard.—*Army and Navy Register.*

Wood Screws.—Diamond-pointed steel screws are a new article made by the Russell & Erwin Manufacturing Company, of New Britain, Conn., and the following advantages are claimed for them: "They can be driven easily with a hammer their entire length into the most thoroughly seasoned oak, maple, hickory or other hard wood when desired; but in ordinary practice, the best results may be obtained by hammer driving part way, and then turning them in with a screw driver. The characteristic features of these screws are, the *pyramidal point*, the *ratchet thread* and the *convex* or *oval head;* the first two greatly facilitate the penetration of the wood without breaking down its fiber when driven by a hammer, the thread is the best shape to engage with the wood while resisting a pulling strain, and the form of head obviates the liability of its breaking or splitting. In all cases they may be withdrawn with a screw driver, whether they have been hammered or screwed into the wood."

Some personal experience with these screws has proved that they are a valuable addition to the outfit of the wood-worker, and that when once used they will not be discarded.

Safety of Passengers.—Governor Hill, of New York, has approved the bill passed by the last Legislature providing for the safety of railroad passengers in that State. This bill makes it unlawful for any steam railroad after May 1, 1888, "to heat its passenger cars of other than mixed trains by any stove or furnace kept inside the cars or suspended therefrom, except that it may be lawful, in case of accident or other emergency, to temporarily use any such stove or furnace with necessary fuel; provided that, in cars which have been occupied with apparatus to heat by steam, hot-water or hot-air from the locomotive, or from a special car, the present stove may be retained, to be used only when the car is standing still; and provided also, that this act shall not apply to railroads less than 50 miles in length, nor to the use of stoves of a pattern and kind to be approved by the Railroad Commissioners, for cooking purposes, in dining-room cars."

The second section of the law provides that, after November 1, 1887, all railroad bridges shall be provided with floor-systems so constructed as to support a derailed locomotive or car; that is, the floor-systems must be so constructed that, in case of a derailment, the locomotive or car will not break through the floor. All bridges must also, from the same date, be provided with guard-rails and guard-timbers, so arranged as to guide the wheels in case of derailment and to prevent the derailed train or car from running off, or striking the side of the bridge. The guard-rails must also be maintained upon the approaches to all bridges. The penalty for a violation of this section is $1,000 for each offence.

Submarine Torpedo-Boats.—The submarine steam torpedo-vessel *Nordenfelt* has just completed what may be considered a most crucial trial trip as a surface-boat in making the voyage, through at times heavy seas, from Barrow-in-Furness—where she was built—to Southampton, in the neighborhood of which she is shortly to prove her use and enormous offensive capabilities. She was during the voyage tested by her commander in every wind and condition of wave and sea, and by her behavior therein she has shown that she will be capable of being manœuvred in any possible weather, however bad; an advantage possessed by no other torpedo-boat. During the trip no attempt was made to test the speed of the new vessel, only one boiler being used, and that without forced draught. The object aimed at was rather to show how far she could be driven at a fair speed on a small consumption; and on the result, namely, 100 miles on just over 1½ tons of coal, Mr. Nordenfelt is to be congratulated. A higher economy than this will, beyond doubt be obtained with higher pressures than it was convenient to use during this her maiden trip, and when we mention that she is capable of carrying on board upwards of 20 tons of coal, it will be seen how wide her operations may be. The vessel is now in Southampton Docks, having such upper gear as was found necessary for the voyage—such as masts, side-lights, bridge-railings, winches, etc.—taken off her, and is being made to look like what she is, a submarine-boat. She is then to be taken out for speed, progressive, and other trials, the results of which will be given in our columns.—*The Engineer.*

Boiler Explosions in 1886.—The *Locomotive* says: "The total number of explosions, so far as we have been enabled to learn, was 185; in many cases more than one boiler exploded, but it is reported as one explosion.

"The number of persons instantly killed, or so badly injured that they died within a very short time after the accident, was 254; the number injured, many of whom were stated by the report to be fatally injured, was 314, or a grand total of 568 persons killed and badly hurt. This is a showing of which the people of the country at large are not, in all probability, at all proud.

"As has invariably been the case, the greatest number of explosions has been furnished by saw-mill boilers, 24.3 per cent. of the whole number being in this class.

"The next in frequency is the locomotive, 22, or nearly 12 per cent. of the whole being furnished the past year by this class. And yet many writers on the theory of boiler explosions make the assertion, to back up some pet idea, that locomotive boilers rarely explode. Facts do not bear out this assertion. The next largest number occurred among the class of boilers used about mines, collieries, etc., 17 being the total. Some of these explosions were very destructive.

"Distilleries and portable boilers come next with 16 each. Some of the explosions in the latter were especially disastrous, their violence would seem to indicate, almost to a certainty strong boilers, plenty of water and very high pressures, probably over-pressure due to neglected safety-valves.

"Rolling-mills and iron works come next with 15 explosions of the usual destructive character common to this class of boilers.

"Steam vessels, which are generally near the head of the list, rank sixth, the total number reported being 14."

Mexican Trade Requirements.—The United States Consul at Guerrero, Mexico, writes: "There is no demand here for machinery of any sort. In agriculture a few small iron plows, it is true, are used, and I believe that they are coming into more general use. The plow used by Mexicans is made out of a crooked fork of a tree, tipped with iron. Their hoes are very wide, heavy, and clumsy. A light hoe would be useless where so many bushes and stumps are left, after their mode of plowing. No mowers, reapers, thrashing machines, or harrows are used or needed, as corn is the only kind of grain cultivated here. Carpenters', blacksmiths' and shoemakers' tools find a ready sale. Washing machines or wash-boards are not used. The washing is done by women, who stand along the banks of the river and scrub the clothes on flat stones, and afterwards hang them out to dry on the bushes. There are no windmills, although they would be particulary useful

for pumping water out of the river for irrigating purposes, as the crops are generally lost because of the drought; and if artesian wells were sunk they could be used for giving water to stock. In fact, neither agriculture nor stock raising can be profitably carried on here without artesian wells and windmills. A few pumps could be sold here at present, especially pumps for cisterns. It would pay some enterprising person to come to Mexico and put down artesian wells and erect windmills, especially on the plains which extend south of the Sierra Madre. When I speak of machinery I only refer to this consular district; in the interior of Mexico considerable machinery is being introduced of all kinds. There is no demand in this consular district for mining machinery and implements, as the only mines here are of coal, and they are not worked at present for want of means for transporting the coal. The nearest silver mines are at Cerralvo and Vallecillo, in Nueno Leon, 90 miles distant. No electric machiney would sell here at present."

A New Valve-Gear.—In a paper on New Constructions of High-speed Engines, presented to the *Verein zur Beförderung des Gewerbfleisses* (Germany), a short time ago, Dr. Proell, among other things, described his system of valve-gearing, which has found much favor with German engine builders. His remarks are therefore not without interest:

In place of four flat-balanced slide-valves, as used in the Porter-Allen engine, a cylindrical oscillating valve is employed, placed below the cylinder. The axis of the valve is at right angles with that of the cylinder. The steam passes through the inside of the valve; the ports are in that part of the surface furthest from the cylinder. The weight of the valve rests on the wearing surface, and all the lubricant from the cylinder flows to it down the steam passages. In consequence of the low position of the valve the condensed water runs off from the cylinder of itself. To insure sufficient admission area with an early cut-off there are two passages in the valve by which the steam can enter. Motion is given through a crank attached to the valve spindle by an eccentric-rod. Instead of the curved link of the Porter-Allen engine a straight bolt is used on which the block connected with the eccentric-rod slides. In order to obtain a constant lead for various degrees of expansion a double motion is employed, both the rod and the eccentric strap being adjusted by the governor. A special construction of governor of Dr. Proell's design is also used; it is of the inverted type, a spring taking the place of the counterweight in ordinary governors. The distinctive feature consists in the fact of the proportions being so arranged that the balls always move approximately in a plane at right angles to the governor-spindle, so that when the latter is vertical no work is performed by the weight of the balls. The action is approximately astatic. In the larger machines of this type a longitudinal reciprocating motion is imparted to the valve, not synchronous with the oscillations of the latter. This, it is claimed, makes the wear very uniform, prevents grooving, and reduces the friction, thus rendering easier the work of the governor.

Cornell University.—Professor R. H. Thurston, Director of the Sibley College (the department of mechanical engineering) of Cornell University, has issued the following circular:

"An unexpectedly rapid growth in the numbers of students registering in the Cornell University for the Sibley College courses, in the past two years, and since their establishment on their present basis, has already crowded that institution to its utmost capacity in many directions, the number in the college having already approached, within 25, that considered the maximum which can be accommodated in the existing buildings. A new building now in progress—under contracts made by the Hon. Hiram Sibley and which will be presented to the University—will, however, increase the total space available next year by 50 per cent., and will bring the total number, as a maximum, when all classes are filled on the new basis, up to 300.

"This enlargement of the Sibley College will make it possible, under the conditions stated in the *Register* of the University, to increase the number admitted into the Freshman Class to 100; while 25 or more may be admitted into the upper classes and the advanced courses of post-graduate instruction. Should more apply than the number just specified, preference will be given to those shown by the results of the examinations for admission to be best prepared. Students unable to register in the Sibley College courses leading to a degree may, if they choose, enter any other courses for which they may have sufficient preparation.

"It is hoped that, at a later time, when further extensions of the buildings, additions of proportional extent to the equipment, and the growth of the income of the University and of the assured income of the college shall have permitted still further development of the Sibley College system of schools and of related departments of the University, the limit, as to numbers, may be again extended so as to permit the admission of all applicants well fitted to profit by such instruction as is here offered. At present, only those who are well prepared can be certain of admission to the courses leading to a degree."

Blast Furnaces of the Uuited States. — The *American Manufacturer*, after giving its usual monthly tables, says: "In a condensed form, the statistics of the furnaces for June 1, is as follows:

	In blast.		Out of blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	62	11,809	116	12,738
Anthracite	145	41,288	60	15,503
Bituminous	104	54,767	105	57,348
Total	311	107,964	281	85,589

The most noticeable change in this report, as compared not only with that of last month but with that for many previous months, is the falling off in the number of bituminous furnaces in blast. Since March 1, 1886, there have not been so few furnaces in blast. At that time the small number, 105 just, was owing to a coke strike, the same cause that has reduced the number of furnaces in blast at the present time. It is probable that if all the furnaces that were banked June 1, had been reported as banked and included in the table as out of blast, the number would have been reduced below 100, a smaller number than has been in blast at any time since November 1, 1885.

"The chief changes have been in the Pittsburgh and Shenango Valley districts in Pennsylvania, the Mahoning Valley and Eastern Central and Northern districts in Ohio and in Illinois, 32 of the 45 furnaces less in blast being reported in these districts. In the South, with the exception of Virginia, there has been an increase in furnaces blowing. Some of the Virginia furnaces use a portion of Connellsville coke and are out of blast or banked.

"Furnaces using other fuel than coke show but little change, though anthracite furnaces, which use considerable coke, would show a considerable falling off in the actual make."

A year ago, on June 1, 1886, there were in blast 308 furnaces (54 charcoal, 123 anthracite and 131 bituminous), having a total weekly capacity of 118,770 tons.

Promotion of Locomotive Engineers.—Mr. G. W. Cushing, Superintendent of Motive Power and Rolling Equipment of the Philadelphia & Reading Railroad, has issued the following circular in relation to promotions:

"Cases having recently come to notice indicating the necessity for a settled, understood system in the matter of promotions of men, this circular is therefore issued for information of employés interested.

"Promotion to road-engineer necessitates regular service as fireman on the P. & R. R. R., and it may become expedient to choose from the ranks of firemen men for switch-engines and work-trains. Where the circumstances are favorable, firemen may first be used as hostlers, until thoroughly familiar with that important line of duty, and advance through the grade of shifting and pusher engineers, to regular road service, if found in all respects capable and worthy. Those firemen will be selected who possess a good record for regular habits, who stand well as men, and who are sufficiently educated in their duty to become creditable to the service. None who are known to use liquors in any quantity as a beverage will be selected; with this in view it will be well for the firemen to seek information relative to their duty, and to fit themselves for advancement; to those who are so disposed, the officials of the railroad connected with the machinery department will cheerfully give such information as time and circumstances will permit. The road foreman will instruct engineers and firemen in all matters they desire to know.

"Those who are advanced to the grade of road engineer will retain that rank. In case at any time it becomes necessary to decrease the number of road engineers, those who are dispensed with will be offered temporary places in a lower grade, the youngest to switch engineers and firemen, but their places in proper rank will be held open for them.

"Selections for passenger-train engineers will hereafter be made from the ranks of freight engineers; the oldest in service, if worthy and capable in all respects, will have the preference. Men who are offered passenger-runs and decline to accept them, will thereby waive their right to the run offered, and it will remain discretional thereafter if they shall again be offered the passenger-run.

"All men employed as road engineers shall be required to

pass examination before the Division Superintendents or their representatives, relative to their understanding of the transportation time-tables, or book of rules, and the interpretation given by the Superintendent must be accepted and acted upon by the engineer. In cases of dullness in comprehending rules, the Superintendent will decline to certify to the fitness of the applicant, in which case he will not be employed as locomotive engineer."

The Vogelsang Propeller.—The Vogelsang propeller is now attracting the attention of Navy men by reason of the remarkable accounts received here of its performances in Europe. It is stated that when applied to a German torpedo-boat, without any increase of power, the speed of the boat was increased from 21 knots to over 26 knots. There is trustworthy evidence that it has increased the speed of a number of launches and other small craft as much as 33⅓ per cent. This invention is about to be tried on one of the North German Lloyd steamers between Bremerhaven and London. It was developed by the inventor at the Washington Navy Yard, an it seems strange that it was never officially reported upon here. Mr. Vogelsang's patent covers the following claims:

"1. A propeller consisting of a hub provided with two or more blades or wings grouped upon but one side and unequally distributed about said hub, but in which the distance between the blades is not uniform, and in which no two blades are diametrically opposite, substantially as and for the purpose specified.

"2. A propeller having its blades grouped upon one side of the hub or shaft only and in which no two blades are diametrically opposite, and in which the distance between the blades is not uniform, and a non-propulsive counterbalance arranged upon the side of the hub or shaft opposite to that on which the blades are located, substantially as and for the purpose specified.

"3. A propeller consisting of a boss or hub provided with two or more blades grouped upon one side only of the said hub, and in which no two blades of the group are arranged diametrically opposite, and a single blade arranged opposite to the group of blades, but in which the distance between the blades is not uniform, substantially as and for the purpose specified."

The inventor says of what he has been able to accomplish: "With propellers in which there are a large number of equally distributed blades, the water is so greatly churned that it is difficult for the blades to obtain a solid hold in the fluid, and consequently the loss by slippage is very great. By arranging the blades as herein described and shown, forming a more open space between them, they are enabled to take a firm hold upon the water, and the slip is much reduced, and this reduction is shown in an increase of speed with a given number of revolutions. It is also evident that as the blades are located to one side, one side of the shaft will take the wear and will run upon the bearing-box, the pressure traveling around the box instead of around the shaft, as heretofore. This change of pressure is very advantageous, as the box may be made with a replaceable bearing, and the life of the propeller-shaft would be greatly lengthened."—*Army and Navy Register.*

The Use of Wolfram or Tungsten.—For the last 30 years the beneficial effects of an addition of wolfram or tungsten to steel have been fully recognized, but the error has so often been made to employ as an addition an impure tungsten that results have varied considerably and have depreciated to some extent the value of the steel. Going on the idea that the cause of this variation in the results is the use of impure tungsten carrying either sulphur or phosphorus, or both, Mr. Theodore Kniesche, of Rosswein, Saxony, started on the plan of producing first a pure tungsten which would secure uniformity of results. Steel alloyed with pure tungsten is remarkable for its hardness and toughness, the cost being only slightly greater as compared to the improvement in quality. It is stated also that tungsten steel is very suitable for the manufacture of steel magnets, since it retains its magnetism longer than ordinary steel. Mr. Kniesche has made tungsten up to 98 per cent. fine a specialty, and has introduced it at Krupp's and a number of Sheffield and French steel manufacturers. Dr. Heppe, of Lindenau, Leipzig, has written a number of articles in German technical publications on the subject. The following instructions are given concerning the use of tungsten: In order to produce cast-iron possessing great hardness an addition of ½ to 1½ per cent. of tungsten is all that is needed. For bar-iron it must be carried up to 1 to 2 per cent., but should not exceed 2½ per cent. For puddled steel the range is larger, but an addition beyond 3½ per cent. only increases the hardness so that it is brought up to 1½ per cent. only for special tools, coinage dies, drills, etc. For tires, 2½ to 5 per cent. have proved best, and for axles, ½ to 1½ per cent. Cast-steel to which tungsten has been added needs a higher temperature for tempering than ordinary steel, and should be hardened only between yellow, red and white. Chisels made of tungsten steel should be drawn between cherry-red and blue, and stand well on iron and steel. Tempering is best done in a mixture of 5 parts of yellow rosin, 3 parts of tar and 2 parts of of tallow, and then the article is once more heated and then as ordinarily tempered in water of about 15° Centigrade.

It has been repeatedly shown that good tungsten steel can also be produced in a Bessemer converter, but the drawback is that part of the tungsten is burned, and its consumption, therefore, is greater than in the case of crucible steel, but it has been successfully tried to carry all of the tungsten added to pig-iron in a cupola. Pure tungsten is a powder, and, therefore, a greater part of it would be blown out of a cupola if it were put in any other form; therefore, the metal is mixed with one part of slack lime perfectly dry and enough hot tar to make small bricquettes. A layer of coke is put on the bottom of the cupola, followed by a layer of these bricquettes, covered with some coke, and then a charge of pig-iron with lime as a flux; following them in regular order charges of coke, bricquettes, pig-iron, etc., until the furnace is full. After the iron is melted it must be well stirred and kept hot for half an hour. Alloys of tungsten with bronze have been found very suitable. A tungsten bronze containing 1½ per cent. of tungsten, 95 per cent. of copper and 3½ per cent. of tin is very tough and rolls well.

The North Sea Canal.—Work was formally begun June 2, on the North Sea Ship-Canal, which is to extend from the Bay of Kiel on the Baltic Sea to the River Elbe near its mouth. This canal will enable vessels to pass from the Baltic to the North Sea, avoiding the long and dangerous passage around Denmark. It will be the realization of a very old project, a canal having been first proposed 500 years ago.

The canal itself, which will be a clear cut from sea to sea, will have locks at both ends, with tide-gates to insure communication at any hour and under any condition of tides or temporary currents. Leaving the Elbe in a northeasterly direction it will be cut through sandy soil to the Lake of Kuden (8 kilometers), where considerable engineering difficulties will have to be overcome on account of the marshy character of the ground. After crossing the Lake of Kuden the canal follows for awhile the valley of the little River Burgeran to the village of Burg, 15 km. from the starting point.

At a point 5 km. further it strikes the river Koltenau, which is crossed and recrossed, and a tributary of which is followed through rising ground to Klein and Gross-Bornholt (27 km.) and Groendal, the highest point of the route. Here excavations to the depth of 30 meters will be made through sandy loam. At Wennbuettel (32 km.) the valley of the Giesel River will be reached. Here the canal turns a northeasterly direction to the East, following the Giesel River for about 10 km. to a place called Oldenbuettel, where a cut of about 4 km. across the land will connect it with the lower Eider at Wittenbargen. This River Eider, and particularly the upper Eider, with the lakes formed by it, and the surface of which is considerably higher than the mean level of the sea, will play an important part in the projected Nord-Ostsee-Kanal. It will be followed from Wittembargen to Bendsburg, a distance of 20 km.; thence the lakes formed by the upper Eider (10 km,) will be used to Steinrade, whence a cut of 7 km. will be made to Koenigsfoerde, and thence to the lake of Flemhude, which will be crossed near it northern end (86 km. from the starting point). The remainder of the Nord-Ostsee-Kanal will be an enlargement of the present small Eider-Kanal with short cuts near the town of Knoop (95 km.).

Near Holtenau, at the terminus of the present Eider-Kanal (built by King Christian VII of Denmark in 1785), the port of Kiel on the East or Baltic Sea will be reached.

The total length of the canal from Kiel to the Elbe will be 99 km. (61.5 miles). It is to have a uniform width of 60 meters (196.9 ft.) on top and 26 meters (85.3 ft.) at the bottom, and the depth of water will be 8.5 meters (27.9 ft.). The German Government is building it, largely for strategical reasons.

Compressed Air Power.—Satisfactory progress is being made with the construction of the central station of the Birmingham Compressed Air Power Company, and in the course of the next two or three months operations will have been so far advanced that consumers will be supplied with the new motive-power to the extent of 6,000 I. H. P. Already applications for 3,500 I. H. P. have been received. As the area for supplying compressed air is limited under Act of Parliament to about 1½ square miles, the operations of the company will at first be confined, but, on their enterprise being attended with success, steps will doubtless be taken to acquire powers or extending the area.

At the central station the air will be compressed to a pressure of four atmospheres by large air-compressing engines, and will be conveyed in mains through the principal streets of the locality, and from these mains service pipes are to be taken to the premises of the company's customers. The works will have a railway siding from the Midland line, from which coal will be tipped direct on the charging platforms of 31 of Wilson's 8-cwts. patent gas producers. Underground flues will carry the gas from the producers to the furnaces of the boilers. The steam injection to the gas-producers will be taken from a separate boiler, and will be governed by air pressure, so that when the air pressure rises the steam injection will be reduced and the fires under the boilers lowered throughout the whole range, and *vice versa*.

When the station is completed there will be 15 engine-houses, built in rows, of strong concrete walls, in the spaces between which will be placed 45 Lane's patent water-tube boilers. Each engine-house will be constructed to receive one triple-expansion beam air-compressing engine of 1,000 I. H. P., driving six single-acting air-compressing cylinders, coupled to opposite ends of the beams, and capable in the aggregate of delivering 2,000 cubic feet of air per minute at 45 lbs. per square inch above atmospheric pressure. The free air will be drawn into the compressors from the top of each engine-house through casings, in which will be inserted filtering screens to clear the air of solid impurities. When the full 15,000 indicated horse-power is at work, 6,000,000 gallons of water will be used daily for the feed, for condensing, and for cooling the air-cylinders. The mains will vary in diameter from 7 in. to 24 in., and will extend about 18 miles. They will be placed in concrete troughs, supplied with removable covers, as near as possible to the surface of the road; and means will be adopted by which, in the event of the bursting of a pipe, the general supply shall not be interrupted. Service pipes will be connected in the usual manner, and Forster's patent joints will be used, so as to allow for expansion, contraction, and for any subsidence or other disturbance. Consumers will have the air supplied through meters of the character of Beale's gas-exhauster, corrected in the readings according to the varying pressure.—*Correspondence of the Engineer.*

A New Telephone.—I was invited to be present to-day at some telephone experiments between Paris and Brussels with a new apparatus known as the "micro-telephone push-button." These experiments, which were made on behalf of the two telegraphic administrative departments of France and Belgium, produced a very lively impression on those present, and I believe the new apparatus to be the most perfect yet produced.

As its name indicates, it has the form of an ordinary electric push-button. When the button has been pushed in, and has made a sound at the other extremity, it is taken out, and is found to be attached to a long electric wire. There is thus exposed the telephonic plate, which is extremely sensitive, so that where it is necessary to speak at short distances it is not necessary to come close to the instrument. For communications in the same street, or the same house, the operator places the upper part near himself, and without changing his position he can speak with the correspondent at the opposite extremity. He is not obliged to put his ear to the part which contains the button and brings back the reply. Thus, for short distances, those who make use of this apparatus speak in their ordinary tone, without changing their customary attitudes. They may sit or walk about, and speak just as if those they were addressing were present. When great distances intervene, as in the experiments performed to-day, in which the speakers and hearers were separated by 200 miles, it is necessary to come nearer to the apparatus, but without being obliged to speak quite close to it.

But what makes this apparatus the most successful of telephonic instruments is, that it can be made for 60 cents, that is to say, for not more than the price of the ordinary push-button. Now, as it can be fitted to the electric wire of the ordinary ringing apparatus, it follows that it introduces a complete change in our ordinary modes of intercourse. At front doors, in the interior rooms of houses, everywhere in short, where the ordinary electric buttons are used, the telephonic buttons may be introduced. It will by this means be possible to give or receive instructions, to know who is knocking at the door, to communicate in short, by speaking as well as by ringing. On the advantage of this in every-day life it is unnecessary to dwell. The railway companies are making experiments with this apparatus as a means of communication between compartments of carriages. It is being fitted up on trial in hotels. I have seen it at work at the door of a private house, where I was replied to by those within without their having stirred from their places, and without the door being opened. Between Paris and Brussels this instrument, costing 60 cents, worked with admirable precision, and it was not altogether without an eerie feeling that I listened to a voice with a slight Belgian accent coming to me from a distance of more than 200 miles.

The inventor is Dr. Cornelius Herz, one day nominated Grand Officer of the Legion of Honor, next day described as an emissary of Germany, and lastly as the friend, adviser and confidant of Gen. Boulanger. He is in reality an electrician whose inventive talent has been stimulated by his residence in America, where there is a boundless demand for improvements in electrical apparatus and in all mechanical contrivances. The French Minister of Posts and Telegraphs, under whose auspices the experiments were carried out to-day, has approved the report made to him, and proposes to give orders for the introduction of the new apparatus into all the public administrative departments as soon as it comes into use, for as yet it has only been an experiment.—*London Times, Paris Correspondence.*

Chicago, Burlington & Quincy Master Mechanics' Association.—The division master mechanics of the Chicago, Burlington & Quincy and its controlled lines, have an association which holds periodical meetings for the discussions of questions of interest to them either generally or in their special relations to the road. As a specimen of their work, we give the following, which were among the questions submitted at the sixth meeting:

602. Should we use check-chains on tank trucks and passenger cars?

603. Is there uniformity of standards in tools, oil cans, etc., furnished engines; and if not now practiced, should not the number of engine and initial of road be branded on tools as far as practicable?

604. Is it desirable that the recess now cast in rocker boxes be left out, giving the rocker-arm the benefit of the full bearing? The rocker box is 12 in. long over all, with a recess in the center. It is claimed that it would cost no more to bore it out with this recess left out, and would wear without lost motion much longer.

605. It is recommended that coach draft timbers be made out of lumber $7\frac{1}{2} \times 4$ in. and 16 ft. long, instead of $13\frac{1}{2} \times 4$ in. and 16 ft. long, and to put the upper 6-in. piece on with bolts and cast-iron keys. The argument is that it would be equally as strong and cost much less money.

606. What is the best arrangement for fastening front doors in extension-front engines?

607. What is the difference in cost of maintenance of balanced as compared with plain D valves?

608. It is recommended that the brake bracket and casting for flat and coal cars be secured to the end-sill by a different fastening. They are now held by one end of the truss-rod of the car, and, it is claimed, the strain of the load on the rod has a tendency to pull the brake staff out of plumb, hence the bracket should be secured independent of the truss-rod.

609. It is recommended that a change should be made in the brake shoe on the M. C. B. trucks where the brake is hung to the truck on the inside, so the car repairers can get the split key in more readily. It is claimed that with the present construction about half of these keys are put in from the bottom, and a poor job is the result.

610. The use of studs is recommended in place of T-bolts in fastening steam pipes to the saddle on class A engines. It is said that T-bolts, when in use 1 or 2 years, rust in and are liable to break the casting getting them out.

611. It is recommended that the stuffing-box and stem be left off boiler checks and a plain cover made. It is said to work better and is cheaper to make.

612. Would it not be better to make the link-block separate from the side-plate instead of solid? It is considered cheaper to make and could be readily closed when worn, while the solid block has to be thrown away.

613. Would it not be better in painting freight cars to use mineral for all work including iron work? It is thought a large saving would be effected and the iron be as well protected.

614. Would it not be better in building and rebuilding stock cars to put the end sills on like they are on flat and coal cars? This would do away with corner irons which it is thought is a detriment to end sills, causing them to rot where covered with iron, and effect economy both in repairs and new work.

616. It is recommended that the location of class A engine water-gauge glasses be raised $1\frac{1}{2}$ in., which, when the water can barely be seen in the glass, will leave 3 in. of water on the crown-sheet, water in the lowest gauge-cock indicating 4 in.; while, it is said, our present location of gauge glass allows but $1\frac{1}{2}$ in. of water on crown-sheet when water can barely be seen in glass and it is considered unsafe.